THE · PRACTICAL PHOTOGRAPHER

(LIBRARY SERIES)

EDITED BY REV. F. C. LAMBERT. M·A·

NUMBER 27.

The Pictorial Work of
W. A. I. Hensler.

Photographic Optics and Lenses

Easy Introduction
with Numerous Simple
Experiments.

The Selection, Care and
Use of Photographic Lenses.

How to Test a
Photographic Lens for
Practical Purposes.

Technical Terms Explained.
Etc.

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76 Illustrations
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HODDER AND STOUGHTON.
27. PATERNOSTER ROW. E.C

December, 1905.

The Practical Photographer.

Library Series. Photographic Optics, etc. No. 27.

Principal Contents.

Illustrations.

Editorial and other Notes.

Our next number (ready January 1st, 1906), will deal with the important subject of **The Optical Lantern** for projection, enlarging, experimental demonstration, etc., together with other kindred optical and lantern matters. This number will contain several reproductions of the choice work of **Mr. Charles H. L. Emmanuel.**

Other numbers now in active preparation will deal with **Gaslight Papers. Telephotography. Chemistry for Photographers. Pinhole Photography. Curiosities of Photography. Oil Printing. Iron Printing. Ozotype. Stereoscopic Photography. Finishing the Print. Copying. Trichromatic Photography. Minor Printing Processes. Photogravure. Photo Ceramics. Photographic Societies, Meetings, Libraries, Exhibitions. Photography for the Press and Commercial Purposes. Pictorial Composition** (2nd part). **Portraiture** (2nd part), etc.

Deferred Print Criticisms.

Out of consideration to the many, we have hitherto deferred publishing criticisms of prize pictures until the prints and criticisms could appear together in the same number. But we have now devised a plan whereby the authors of the winning prints will receive privately an advance criticism. We hope to put this method into practice at once, and take the present opportunity of heartily thanking our numerous and esteemed prize winners for their greatly valued patience and good nature.

Criticism of Prints.

It is our desire to make the criticism of prints a special feature in our pages. The Editor gives his personal careful attention to this matter, and aims at making every criticism a practical, interesting, and instructive object-lesson. By paying attention to the hints thus given, often a poor print may be improved and a good print followed by one still better. In order to encourage readers to take great care in the preparation of the prints they send us, we offer **Fifteen Shillings in Prizes** for the best three, four, five, or six prints sent in each month. The winning prints will not be returned. (See Coupon).

General Notices.

1. It is particularly requested that any errors in the spelling of **Award Winners' names** should be notified to the Editor immediately they are observed.

2. Will contributors to our various competitions kindly refrain from sending *under one cover* prints for *different* competitions? This not only gives us considerable trouble, but involves the risk of the various pictures not being properly entered for the competition for which they are intended. It is far better for all concerned to send each lot of prints in separate parcels.

3. Will competitors please notice that the latest date for receiving prints for our competitions is that given on the coupon, and that we *cannot admit late arrivals?*

4. Will competitors please bear in mind (1) that the judging and criticism cannot be done until after the closing date of the competition. (2) that we go to press before the 25th of the month, and (3) that the criticism of a large number of prints takes considerable time?

5. In response to numerous requests from our correspondents we have pleasure to announce that we will do our best as far as space permits to reply to queries of a photographic nature. Will querists please (1) write plainly, (2) on one side of the paper, (3) as briefly as is consistent with clearness, and (4) give us the indulgence of their kind patience? *(Vide* Coupon).

Reminder.

The Beginners' Junior Salon closes Dec. 31, 1905. Entry forms, etc., on page viii. (next to page 64), *Practical Photographer* 25.

This Coupon Expires December 31st, 1905.

THE PRACTICAL PHOTOGRAPHER. COUPON No. 59.

Prints for Criticism (or Queries).

RULES.

1. Write legibly, on one side of the paper only.
2. Put your name, address, and a number on the back of each print, and enclose this coupon.
3. Do not send more than three prints with one coupon.
4. State the *Month, Hour, Light, Plate Speed, Stop,* ☞ *Exposure, Developer, Printing and Toning* process employed.
5. If prints are to be returned, a stamped and addressed label or envelope *must* be sent **with the prints.**
6. The Editor reserves the right of reproducing any print sent in for criticism.
7. Prints should be addressed:—THE EDITOR OF *The Practical Photographer* (Print Criticism), 27, PATERNOSTER ROW, LONDON, E.C.

Print Criticism. Awards:

The entries for this competition last month were quite up to if not slightly ahead of the average of previous months, both as regards number and quality. The first six to take the usual monthly awards are: H. H. House, "Ploughing near Southampton"; W. E. Hughes, "The Dreamer"; N. S. Heycock, "In a Norfolk Wood"; J. Perrin, "Beech Leaves and Seeds"; F. A. Tinker, Figure Study; O. C. Wilmot, "Reapers." The next six who were pressing very close indeed on the heels of the winners are: W. S. New, R. Low, T. B. Sutton, Mrs. Brooking, F. E. Tinker, E. S. Maples.

Marine, River, Lake, etc., Competition. Awards:

We have been agreeably surprised and gratified, not only by the number of entries, but also by the high average of work sent in for this competition. This has made the task of judging one of considerable difficulty, as so many of the competitors were pressing very closely on each other's heels. The long list of **Certificates** and also **Highly Commended** show the very gratifying quality of much of the work.

Silver Plaque: W. J. Appleby, "On the Banks of the Medway."

Bronze Plaque: R. Low, "After the Storm."

Certificates: Mrs. Helen Wootton, "A Water By-way"; John A. Dickie, "Geiranger Fjord"; J. Perrin, "Amidst the grandeurs I rush heedless on"; T. B. Sutton, "A Freshening Breeze"; George L. Sutcliffe, "The Sweep of the Bay"; E. S. Maples, "An East Coast Breaker"; R. Marshall, "A Cottage by the River Allan"; J. J. C. Shelly, "Morning on the Sea"; J. W. Goldson, "The Wave Crest"; Kumar Rajah of Bobbili, "Marine Study"; H. P. Wight, "Sea Urchins"; R. Mark, "The Pool"; G. D. Swan, "Thames Toilers."

Highly Commended: Major Gorton, M. W. Jones, W. W. Hide, G. A. Fowkes, Nurse F. Davis, C. B. Henning, Dennis Fergyson, H. E. Staddon, W. S. Crockett, J. H. von Thurn, Miss M. I. C. Mason, Basil Schön, C. J. Cave, W. H. Nithsdale, J. H. Segar, E. T. Robson, O. W. F. Thomas, A. Cohen, I. T. Strang, J. Noel Hill, James H. Saunders, M. Carle, Alfred Bates, A. Stafford.

P.P. COUPON 60 H.C. C. *Class*........... *Office No*....................................	*P.P.* COUPON 61 H.C. C. *Class*............. *Office No*....................................
P.P. COUPON 62 H.C. C. *Class*........... *Office No*....................................	*P.P.* COUPON 63 H.C. C. *Class*............. *Office No*....................................

Hand-Camera Competitions.

Class A.—Landscape or seascape, with or without subordinate figures, cattle, etc.

Class B.—Portraits, groups, figures, street scenes, etc.

Class C.—Objects in rapid motion, *e.g.*, waves, trains, animals, sports, etc.

Class D.—Curiosities, rarities, burning buildings, train accidents, strange animals and plants, curious customs, etc.

Please read the following Rules and Instructions carefully before sending in Prints.

1. The negative from which the prints are made must have been exposed in a hand camera.
2. Prints may be by any printing process, and of any size (enlargements debarred).
3. Each print must be mounted and not more than one print placed on one mount.
4. Framed pictures are ineligible.
5. On the back of each mount must be legibly-written :—Name and address of competitor ; title or description of picture ; month, hour, light, plate or film, stop, and exposure ; and the class in which it is desired to enter the print. This last-named detail is to be made on the form provided for that purpose as explained in the next paragraph.
6. In this number of *The Practical Photographer*, will be found four small entry forms marked "*The Practical Photographer* Coupon, 60, 61, 62, 63." One of these is to be cut out and pasted or gummed to the back of each print. The space for the Class letters to be filled up by the competitor and the other space left blank for office use. Four more coupons will be published in our next issue.
7. Competitors may use all the eight coupons to enter eight prints in one class, or distribute their coupons among the various classes as they please.

Awards.

8. Silver and Bronze Plaques and Certificates for each of the four classes will be placed at the disposal of the judges, who shall have liberty to withhold awards from any class wherein the prints are, in their opinion, of insufficient merit. Or they may transfer the awards from one class to another if the number or quality of the prints suggests this course.
9. Unsuccessful prints will be returned if a stamped and directed envelope is sent with the prints.
10. Prints winning plaques or certificates will not be returned; and the Editor reserves the right to publish any such winning prints, either in *The Practical Photographer*, or in the **Special Double Number** now in active preparation. This special number will be devoted to Hand-Camera matters, and be called "**The Hand-Camera Companion and Guide.**"
11. Prints for competition must reach the Editorial Office not later than **February 1st, 1906,** and the package must be addressed as below :—

The Editor of *The Practical Photographer*
(Hand-Camera Competition),
Messrs. Hodder & Stoughton,
27, Paternoster Row, London, E.C.

N.B.—The Editor will be pleased to consider any short notes, hints, or suggestions calculated to make "**The Hand-Camera Companion**" as complete and comprehensive as possible. These should reach the Editor before the end of the present year.

Fig. 1 (p. 3). W. A. I. Hensler.

THE THAW.

THE PRACTICAL PHOTOGRAPHER.

Library Series. No. 27.

The Pictorial Work of W. A. I. Hensler.

By THE EDITOR.

MR. HENSLER'S pictorial work not only possesses several features of special interest in itself, but also contains many hints well calculated to prove of great use to the inexperienced but ambitious pictorialist.

Mr. Hensler's acquaintance with photography dates back to what we are accustomed to hear called "the good old collodion days," although it would not be easy to find any present-day pictorial workers willing to go back to the methods of those toilsome and anxious days. The various calls upon his time in those days did not permit any extensive practice of the "black art," as it was then not inappropriately called, and it was not until some twenty years later, with its acceptable leisure, that he took up photography with the dry plate. As is often the case, his earlier attention was chiefly given to technicalities and the making of topographical views. This is by no means a matter for regret, for the greatest help an artist can have is a sound mastery of the craft side of his art, so that it may become his obedient and fruitful servant.

About this time the now well-known Hackney Photographic Society was formed, and Mr. Hensler most wisely joined that society. He readily admits that he owes much to the help gained through the

exchange of ideas and experiences at the meetings and excursions of this body, which includes amongst its members some of the foremost technicians and pictorialists of our day; the lectures, demonstrations, friendly criticisms, and informal discussions all aiding in the storage of art as well as craft knowledge, and the avoidance of eccentricities.

As regards apparatus, materials and methods he is wisely catholic and broad-minded. While each may have its special virtues or properties, perfection belongs to no one of them, and all are used in turn as occasion may necessitate. In a friendly letter to the present writer Mr. Hensler says: "I know that good pictorial work can be done with a box and a piece of copper-foil pierced by a needle, but at the same time I appreciate a good lens, as it gives me an immense reserve of power."

Those of my readers who have seen his fine, impressive 15×12 pictures on the walls of our leading exhibitions may be interested to know that these are primarily due to quarter-plate negatives. They are either enlarged direct on to moderately rough bromide paper, or are carbon or platinotype contact prints from enlarged negatives derived from an original of quarter-plate size. This should serve to stimulate the user of a small camera and make him recognise the fact that size, though perhaps an aid in composing the picture on the ground glass, is not essential for good work. It is but another instance of the truism that quality does not depend on quantity.

On the whole his preference is for the method of enlarging on to bromide paper, as he finds this gives the greater degree of pictorial control. The type of print usually aimed at is that which gives a long range of tone scale with abundant gradation; but at times the subject demands a curbed treatment. However, a comprehensive glance at the accompanying selection of pictures, which may be regarded as representative and typical, will show that his leanings are towards scenes of brightness and light, space, air, warmth and sunshine. He says: "I have learned to see beauty in all the various effects in nature in her

manifold and changeful moods, but perhaps of all the effects that which most appeals to me is the golden glory of the sunshine in happy combination and contrast with strong shadows."

It is once again interesting to note the combination of the pictorialist and musician. Mr. Hensler has for long been an ardent music lover as well as an expert performer on the violoncello. Indeed at one time it was a tough battle between the 'cello and camera, but in the end the latter won, and the readers of these pages are the gainers by this victory, which enables them to have a series of examples which will well repay careful study.

Mr. Hensler's work is characterised by careful attention to manipulative details founded on a good sound knowledge of the technicalities of our craft, and this is combined with a certain indescribable, but yet unmistakable directness in dealing with his subject. This does not mean that he just plants his tripod down anywhere and takes chances ; for on the contrary he spares no pains or time in viewing his subject from every standpoint and under different lightings, etc. But having selected his picture *then* he deals with it in a direct way—aiming to secure and convey the unity of effect which nature offered without any striving after startling or dramatic effect. Consequently there is in all his work a certain attraction that only comes when one is made to feel the absence of affectation in the worker.

Fig. 1. "**The Thaw.**"—This scene comes before us at a particularly opportune moment of the year. It is a simple and dignified composition showing much taste in the graceful arrangement of the leading lines of the picture. Let the student cover up for a moment the lower two inches or so and he will then recognise the vast importance of the foreground. In our reproduction the sky-part prints out just a shade too strongly, therefore the reader must please imagine that he is looking at a 15 × 12 print with a sky-part not quite so dark. The delicate gradation of the snow should be carefully noted.

Fig. 2. "**Towing the Barge.**"—From winter to

summer seems a sudden jump, but it is none the less pictorially refreshing and agreeable. Here or elsewhere it will be noted that our artist pays great and discriminative attention to the sky part of his pictures. Note also that although the calm water in the distance is shimmering with reflected sky light it is not blank paper. The "wiggle-waggles" of the mast reflection in the gently heaving near water are by no means the least important part of the picture, as we may easily see by covering them up for a moment.

Fig. 3. "**A Haven of Rest in a Great City.**"—This is just the kind of picture that the thoughtless person fancies he could do, but closer examination of such subjects tells us that not only is there need for an unlimited store of patience to wait for the exactly right moment, but also a rapid and clear mental perception to tell one that it *is the* right moment. Here again the sky is by no means blank paper, but happily sunned down to just the right degree to suggest a sunlit scene, softened by that peculiar semi-luminous haze which seems only to be found in the oases of great cities. Personally we lean to the opinion that a small strip might be advantageously removed from the bottom of this composition.

Fig. 4. "**Weed Burning.**"—There is something particularly English about this very simple and yet attractive picture. Of course, the observant student will at once see that the fates were not propitious in arranging the position of the boy in the distance to come just behind the back of the old man, but in spite of that the *tout ensemble* is distinctly pleasing. The old man, over-shadowed by the rugged old tree, the smoke-softened distance, the quietness of the autumnal note, all seem in pleasant harmony.

Fig. 5. "**Dutch Girls Knitting.**"—Owing to the peculiar surface of the paper of the original in this instance our reproduction does not adequately convey its rich and juicy effect. This is an instance also where a moderate measure of size seems essential to the scene. We must, therefore, ask our readers to please imagine that they are looking not

Fig: 2 (p. 3). W. A. I. Hensler.

Towing the Barge.

Fig. 5 (p. 4). W. A. I. Hensler.

A haven of rest
in
a great city.

at a 6×4, but at a rough surface print say 12×8 inches. The grouping of the two knitters at the bottom of the stairs is particularly happy.

Fig. 6. "**A Fire Engine Station.**"—Here we have Mr. Hensler in one of his happy moments, *i.e.*, dealing with a flood of rich warm sunshine, enforced by strong, but not unnatural, shadows. The picture well exemplifies Hunt's saying to the effect that picturesqueness is largely, if not entirely, a matter of light and shade, although we are all apt at times to think it is some subtle quality connected with the sentiment of the scene.

Fig. 7. "**A London Water-way.**"—Probably this will be regarded by many as the first favourite among the pictures here reproduced. It certainly is a charming composition rendered with skill which tends to make one envious. The suggestion of the pale blue-gray haze which so often overhangs the Thames is conspicuously successful. The buildings, though softened by it, are yet adequately defined and differentiated, and plane after plane retreats in orderly sequence. One might refer the beginner who asks us what is aërial perspective to this picture for an answer and an example.

Fig. 8. "**Sandhills and Sunshine.**"—There is something particularly tender and delicate in this charming bit of artistic craftsmanship. Every bit of the picture seems to suggest the idea of delicate subtle gradation and gracefulness of line. It is a common but grave mistake to think that an impressionistic work is always fuzzy and out of focus, and likely enough Mr. Hensler has never regarded this as a work of that character. Still it might well be so called on the strength of its complete unity of effect and singleness of *motif.*

Fig. 9. "**In a Pine Wood.**"—This, though by accident last on our list, is by no means least in merit or success. Indeed it has the double interest of being a quite charming picture and an apt example of the use of pinhole photography. The picture as a whole is a very happy bit of composition. The fact that Mr. Hensler used a pinhole

rather than a lens shows us that he is not the slave of his methods, but uses each in turn as the needs of the case require. We are free to confess that we ourselves have a strong liking for the use of a pinhole for certain kinds of work, and our readers may be interested to know that we hope to deal with the subject somewhat fully in a practical and pictorial manner in one of our not very distant numbers.

Without a moment's hesitation we ask Mr. Hensler to accept the hearty thanks of all our readers, in addition to our own, for his kindness in readily placing at our disposal and unrestrained selection, his large and deeply interesting collection of prints. The would-be picture maker may learn from every one of the examples here given not one but half-a-dozen valuable hints. And it is by a wide and catholic study of works of all schools of thought that a sound knowledge is built up on a wide and firm foundation.

Preliminary Note.

OUR chief aim in selecting and arranging the notes in this number is to provide the practical worker with an easy introduction to the subject, which shall give him just as much information as he needs know for the intelligent *selection* and *use* of his lenses. We have outlined a number of easily performed experiments which will help the beginner to grasp the principles of this matter. Theoretical topics are omitted as far as the circumstances of the case permit. Technical terms are *not* shirked, for the simple reason that we are constantly meeting them in lens-makers' catalogues and elsewhere. The diagrams in many cases are purposely exaggerated for the sake of clearness.

Introduction to Photographic Optics.

HOW does a lens form an image? Why is the image upside down? Why are objects at different distances in different degrees of sharpness? Why does a short-focus lens have more "depth of focus (so-called) than a long-focus lens"? These and a score like questions at some time or other present themselves to the thoughtful worker. While these questions cannot be answered in a single sentence, yet a very little knowledge of optical matters will greatly help to make them intelligible; and the worker who has some understanding of such things (even though his chief aim be the making of pictorial photographs) will be the better able to apply the tools in his possession for the securing of what he has in his mind's eye. Once let him make himself familiar with a *few* fundamental principles, and he will be agreeably surprised to find how simple the matter is so far as the *practical application* of these principles is concerned.

Experimental Knowledge.—By far the easiest, most agreeable, and convincing method of dealing with these matters is by way of simple experiments; therefore we strongly urge the reader to follow us in *repeating* for himself, *i.e.*, with his own hands and eyes, the few experiments here set forth, even although he may have read about them elsewhere, or have seen similar experiments made by others in the lecture-room.

A Straight Line.—We all have a fairly good notion of what this is, although we may not be able to express it in a few words. The definition "the nearest distance between its extremities" gives us a valuable idea. If we take any small heavy object *e.g.*, a key, knife, etc., and fix this to one end of a piece of cotton, and seize the other end, letting the cotton and weight hang straight down, we get an illustration of nature using a straight line. When this "pendulum" is at rest it remains in the *vertical*

direction. Now half-fill a saucer with water and add a few drops of muddy ink from the inkstand. Suspend the cotton pendulum above this so that the weight nearly touches the surface of the liquid. Looking down upon the surface of the water, we see our pendulum *reflected* by the water. As we walk round the saucer, no matter where we stand, so long as we can see the surface of the water it gives us a *reflection*. Replace the key by a smaller heavy object, *e.g.*, a bullet, or deepen the water so that we can immerse the heavy object in the water. Now note that the cotton and its reflection seems to be one and the same straight line. The surface of the water we speak of as a *horizontal* surface, and the string is perpendicular or *normal* to this surface.

Light Travels in Straight Lines.—Take three pieces of card (say 6 × 3 inches) and with a red-hot knitting needle burn a small hole in the centre of each card. Take a straight piece of wood, WW, two or three feet long, and with a drop of sealing wax fix the three cards to it at equal distances, so that the three holes in the cards are in a row (fig. 24). Holding the apparatus in a vertical direction, pass the cotton, SK, of the pendulum through the three holes, A, B, C. If the holes are in a *straight line*, and the apparatus is held so that they are vertically under each other, then the cotton will hang freely without touching any of the three cards. Remove the cotton and place the eye close to A, and look through A, B and C at a lamp or candle flame, or any other brightly-lighted object, in a darkened room. When the flame is in a straight line with the three holes we can see it, but if we swerve the apparatus to one side we no longer see the flame, though we may see some object lighted by the candle. This is, of course, a very crude experiment, but it serves to bring home to us the fact that the light from the candle flame to our eye travels in a straight line.

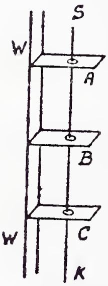


Fig. 24.

A Proviso.—But we must not rush to the conclusion that light *always* travels in straight lines. Indeed, if this were the case our lens would not form

WEED BURNING

Fig. 4 (p. 4).

W. A. I. Hensler.

Fig. 5 (p. 4). W. A. I. Hensler.

Dutch Girls Knitting.

an image on the ground glass. Light only travels in straight lines when the *medium* or material is of the same density or homogeneous; or, as the learned professors express it, by saying that "light is rectilinearly propagated in homogeneous media." If we took our three-card apparatus with us into a tank of pure water we should have the same effect as we had in air, or if the water in the tank were sea-water the same thing would hold good. But if the lower part of the tank held sea-water and the upper part held pure water, and our apparatus were long enough to have one end in the sea-water and the other in the pure water, the case would then be different, because our observations would not then be confined to one homogeneous medium.

Refraction. We can best bring this home by a well-worn but typical experiment. On the bottom of the inside of a dry tea-cup drop one tiny drop of sealing wax S about the size of a large pin's head, Fig. 25. In the cork of a bottle B, insert a pin P.

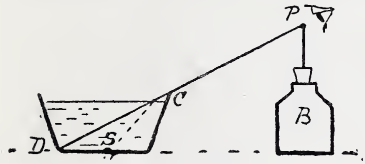


Fig. 25.

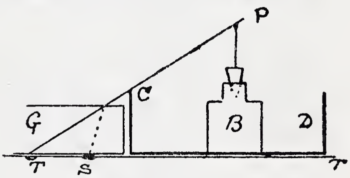


Fig. 26.

Place the cup and bottle on the table and arrange their positions so that when the eye is about ten inches from the pin's head and looking into the cup we can just see the pin's head P and also the drop of sealing wax S. Now increase the distance between the bottle and cup, so that the spot S is just, but quite out of sight. Then pour water into the cup when the spot S will again become visible. From this we conclude that the line of sight P C S is bent or *refracted* at C, *i.e.*, where the air and water meet.

But as our photographic lenses are usually made of glass and not water, it is desirable to repeat this experiment with glass. For this purpose an ordinary thick clear glass paper weight will serve admirably; but failing that, we may use a dozen clean lantern cover glasses, bound up into a

solid mass for the moment by means of a piece of thread. On the table lay a piece of white paper, TT, Fig. 26. Take a piece of card, CD and bend up about one inch at one end at right angles to the other end (or use a box lid). On the white paper make a black dot, S, with ink. Now arrange the bottle and pin PB, the card CD, and the dot S so that when the eye looks along the pin's head P and edge of card C the dot is just out of sight. Now bring G the glass paper weight into position as shown in the diagram without disturbing any other parts, when S the dot will be seen. Thus the line of sight PCS is bent or "refracted" at the point where the glass and air meet. Now increase the distance between the bent-up card C and the bottle B until the spot S is *only just* seen. Then remove the glass G and again looking along PC make another dot T on the paper in line with P and C. The distance between T and S will give us a rough measure of this refraction.

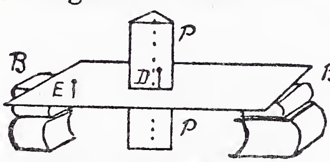


Fig. 27.

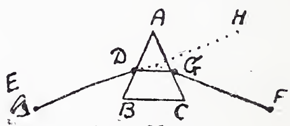


Fig. 28.

Tracing the Refracted Ray.—For our next experiment it will be convenient to have a small triangular glass prism. We can buy a one inch face equilateral prism for about 1/6 at any practical optician's shop, and the investment will be worth the making for various experiments. Failing the possession of a prism, we can manage with one of the triangular glass "drops" or prisms usually attached to chandeliers. (Failing this we *can* manage with a glass letter weight which has a right-angled corner.) We also require a sheet of stout card, a piece of white paper and a few pins—preferably black.

Lay the paper on the card, and place the prism about the centre of the paper. If the long glass drop is being used, we must cut a hole in the paper and card just large enough to permit the glass, PP, to pass through, and yet be held up vertically as shown in Fig. 27. The card in this case is supported

by one or two books, BB, placed below the edges. Turning now to Fig. 28, we may imagine that we are looking vertically down upon the sheet of paper, and that ABC is the triangular outline of the prism, which in the one case may be a hole in the paper, or a triangle drawn by running a pencil round the prism resting on the paper. First stick a pin into the card at D, close to and at about the middle of the side, AB, of the prism. Put a second pin in some such position as E. Now place the eye behind E, and get E and D in line. Then take a third pin, G, and (without paying any regard just now to any fringe of rainbow-like colours), move it along the side, AC until in some such position as G, it *seems* to be in line with E and D. Then take a fourth pin and find some such position as F, so that all four pins *seem* to be in line. If now we remove the prism and place a ruler along E, D, and draw the line, EH, and again place the ruler along D, G, and draw the line, DG, and similarly draw the line GF, we get the path of the light passing from F to E. Also let us note that the angle made by the two lines, EH and FG is called the *deviation* of the ray, FGDE. Now repeat this experiment, without moving D, but shifting E more to the right or left, and note the corresponding changes necessitated in the positions of G and F.

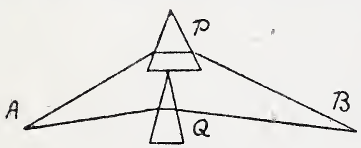


Fig. 29.

If the reader is lucky enough to possess a couple of prisms, P, Q, having different angles, he may make the following interesting and pertinent experiment. Suppose the prism P to have the more obtuse angle of the two prisms as shown in Fig. 29, noting that the prism Q, having the more acute angle, points towards the base of the more obtuse prism P. Now trace the course of a ray through Q in the manner just described, and then repeat with P. By trial and error we may find such a position of A, B, P and Q, so that the eye at A sees the pin B through either or both prisms in the same position; so that the pin, B seems to be in just the same position as we hide

first one and then the other prism by a piece of card. Here, then, we have the fundamental essence of how a lens forms an image. Now a moment's consideration will show us that in Fig. 28 we are only using that part of the glass of the prism which lies between the pins, D and G, and that we could cover up or cut away all the other part of the glass without interfering with our experiment. Suppose we took the tip end of a somewhat obtuse prism, P, Fig. 30, and fitted this on to the middle part, Q, of a prism with a somewhat less obtuse, *i.e.*, more acute angle, and again fitted this on to the base part of a still more acute prism R, and that we repeated this with three other portions, PQR, and then put the two lots base to base, we should have something like the arrangement shown in Fig. 30. And from what has just been said in our previous experiment we see that we could find two points, A and B, such that all six pieces of glass gave the same effect. That is to say, that if the eye were placed at A and a pin at B, then the pin would not appear to change its position as we viewed it in turn through the six several pieces of glass.

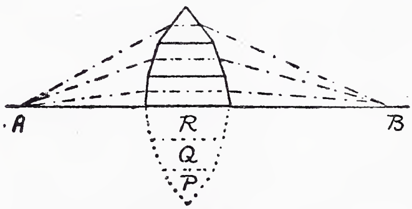


Fig. 30.


Fig. 31.

It is now an easy thing to imagine that in place of the six pieces of glass we had an infinitely large number, and that they were all cemented together, and that we ground off their sharp edges. The result would be practically a portion of a lens shaped like that shown in section in Fig. 31. In our prism experiments we have confined our attention to the path of the ray of light, which was close to the surface of the paper.

But we may regard a bi-convex lens as made up of an infinite number of small portions of prisms

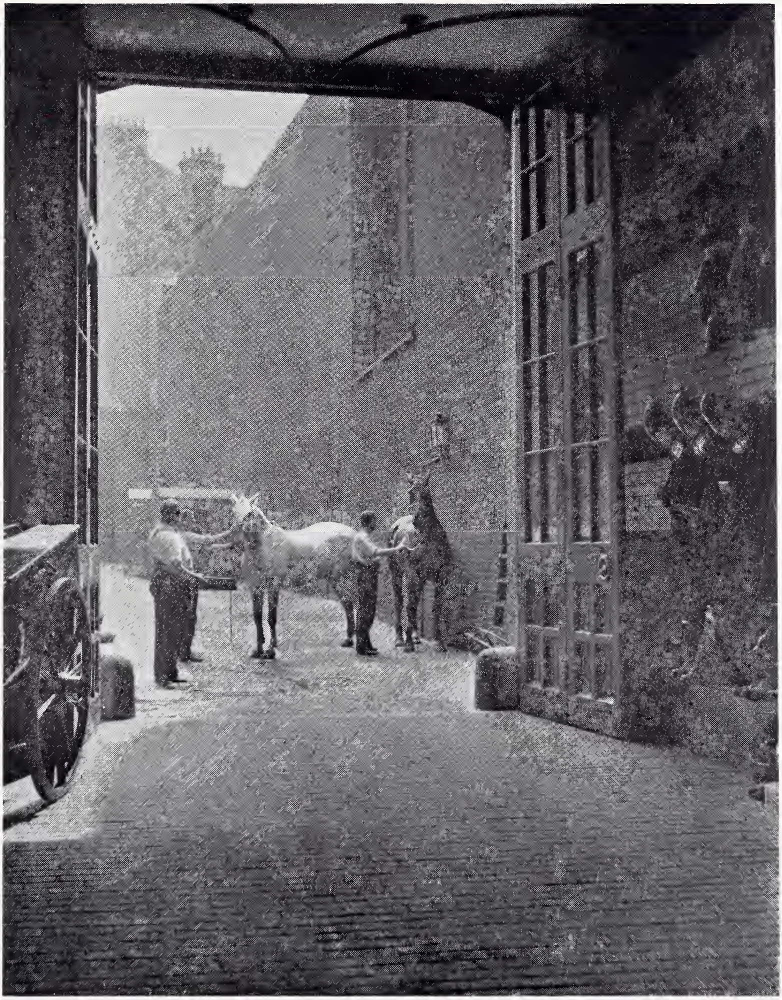


Fig. 6 (p. 5). W. A. I. Hensler.

A
Fire-Engine
Station.

Fig. 7 (p. 5). W. A. I. Hensler.

A LONDON WATERWAY.

arranged in concentric circles round the central thickest portion, and all evenly increasing in angle and diminishing in thickness as they are further away from the thickest central portion, until we reach the margin when the angle is greatest, and the thickness reduced to nothing at all. Hence any two parts of the lens equally distant from the central portion will be similar and act similarly. This we may easily verify by taking a bi-convex lens such as that commonly used as a reading glass, and cutting a hole in a piece of card just large enough to hold it across its centre. We can then repeat the experiment of Figs. 27 and 28, page 10, and rotate the lens in the card opening, thus bringing various portions in front of the pin D.

Conjugate Foci of a Lens.—If the reading glass is fixed in a rim, to which is attached a handle, it is a convenient method to fix this handle into the neck of a bottle and thus enable us to place the lens in any desired position on the work table (Fig. 32). Or the reader may prefer to use the "single" lens of his camera outfit, or one half of a symmetrical or similar compound or doublet lens.

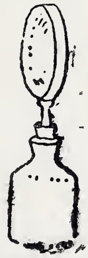


Fig. 32.

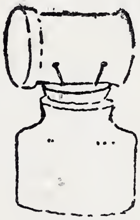


Fig. 33.

Fig. 34.

To hold this in its lens mount or tube we may use a squat-shaped, wide-mouthed bottle having a broad flat cork. The lens tube is laid on this and kept in position by a couple of large, long pins on each side of the tube (Fig. 33). For our next experiment it is convenient to have two similar bottles. In the cork of one of these is made a vertical slit, and into this is put a piece of white card. By means of three long, slender nails or stout pins we can hold a piece of ground glass in a vertical

position by arranging two pins on one side of the glass and one on the other side (fig. 34). We also need a lighted candle which in turn may be conveniently held vertical by letting a few drops of the melted candle wax fall on a small square slab of wood, and at once placing the flat end of the candle on the melted wax. Or the candle may be put into the neck of another bottle.

In the experiments now to be made we must endeavour to place the centre of the lens, candle flame, and centre of focussing card or ground glass in a straight line, and also have the plane of the card or ground-glass perpendicular to this line, and also the lens exactly full face towards the flame, *i.e.* not sloping or at an angle, so that the straight line connecting the centre of the flame and centre of card passes through the central (thickest) part of the lens, and strikes this part in a normal or perpendicular manner (Fig. 35).

Fig. 35.

In a darkened room put the lens on the middle of a table, the candle two or three feet away from the lens, and the ground glass or white card on the opposite side of the lens. By moving the candle and card nearer or further away from the lens we are able to get *an inverted or "upside down" image* of the candle flame on the card. By a few experimental trials we may show

(1) That if the candle is moved *away from* the lens, the card or focussing screen has to be moved *nearer to* the lens to get a sharp image, and *vice versa.*

(2) That for each distance of the candle from the lens there is one and only one distance of the ground glass for a sharp image. Suppose that we find that when the candle is 30 inches from the lens that the ground glass has to be 15 inches from the lens. If we put the candle 40 inches from the lens then the ground glass will be $13\frac{1}{3}$ inches from the lens. If we put the candle 50 inches from the lens the ground glass will be $12\frac{1}{2}$ inches from the lens. Thus we should have found three pairs of corresponding or *conjugate* distances for this particular lens.

(3) We next note that increasing the candle distance from 30 to 40 inches, reduces the image distance 15 to $13\frac{1}{3}$, and that a second increase of ten inches in the candle distance, *viz.*, 40 to 50 inches, necessitates a less alteration of the ground glass distance, *viz.*, $13\frac{1}{3}$ to $12\frac{1}{2}$. And as we increase our candle distance the rate of progress of the ground glass gets less and less, until we arrive at such a state of affairs that any further increase of candle distances seems to call for no appreciable alteration in the position of the ground glass distance.

But our table or room may not be long enough to arrive at this state of affairs, so we may betake ourselves to another room with a window opposite some distant object, *e.g.*, a building fifty yards or more away. By opening the window and placing our lens and card on a table at the end of the room opposite the window, and shielding the card from daylight other than that passing through the lens, we can get a small but fairly bright image of the distant object. And we shall now notice that any objects still further away seem all equally sharply defined. The distance between the lens and card is the *conjugate* for distant objects and this distance is often spoken of as the *focal length* of the lens. Let this distance be carefully measured and let us return to our darkened room again. Take yet another bottle, and in the cork fix a blackened card. In this pierce a small hole, say $\frac{1}{8}$ in diameter, and arrange the candle flame to come as close as possible to this hole in the card. Now place the blacked card (with hole) at the measured distance from the lens, *i.e.*, the conjugate for distant objects or focal length of the lens. Now put the white card or ground glass on the opposite side of the lens and note that we have a circular disc of light, and that the size of this disc is the same whether the white card be near to or far from the lens. If there be dust or tobacco smoke in the air you will probably notice a "parallel beam" or cylinder of light issuing from the lens. If now we move the lens a *little* nearer the blacked card we shall find that we have a diverging cone of light coming from the lens, or that our disc of light is larger as we

increase the distance between the lens and the focussing screen or white card. The practical application of our observations will subsequently appear.

(4) Having observed two conjugate distances, which we may suppose, by way of example, to be the candle at 50 inches and its image at $12\frac{1}{2}$ inches, then interchange their positions by putting the candle at $12\frac{1}{2}$ inches, when the image will be found at 50 inches distance. This teaches us a most important practical principle, *viz.*, that the positions of the object and image are interchangeable. Or as it is sometimes expressed by saying that the actions of light are reversible. Upon this depends the making of photographic enlargements.

Focal Length of a Lens.—We have just seen that the focal length of a lens is the conjugate for objects at an infinite distance, or we may otherwise express it as the conjugate distance for a parallel beam of light. It is sometimes called the equivalent focal distance. It is an item of some considerable importance, and every practical worker ought to be able to determine this distance with reasonable accuracy. It is not desirable at this stage of our experiments to linger over this matter, as it will be more convenient to deal fully with it in a subsequent section. But we may give one easy method of finding the equivalent focal length of lens (single or doublet) which calls for no calculation beyond the application of a foot rule or tape measure. Take an old quarter-plate negative, preferably one which has been developed for full density. Lay the tape measure across the long way of the negative and find the centre. Make a pin scatch A. Then at $1\frac{1}{2}$ inches on each side of the centre make another scratch. Now with an old knife or stout pin and a ruler make a clear, sharp line about $\frac{1}{16}$ inch wide, B and C. These two parallel strips, B and C, are 3 inches apart. Fix this negative vertically by means of a bottle, flat cork and 3 pins (Fig. 34). Behind each of the clear strips B and C put a lighted candle. Take

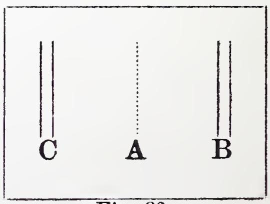


Fig. 36.

a piece of white card ¼-plate size, and in a similar manner put two pairs of dots, MM NN corresponding in position with the tops and bottoms of the two clear strips, B and C. Now put the white card and scratched negative at about equal distances on each side of the lens, and move them to and fro until the bright line images of B and C are sharply defined and at the same time just fit between M M and N N. Then remove the lens and measure the total distance between the negative and the white card and divide it by four. Suppose the total distance to be 44 inches, then the focal length of that lens is one-fourth this distance, *viz.*, 11 inches. This method is not strictly accurate, but for the ordinary needs of the practical photographer it is usually sufficient, and will serve our purpose for the present.

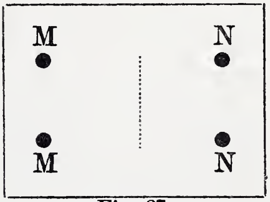


Fig. 37.

Dispersion.—For our next experiment we require a strong but small source of light such as the crater of an electric arc. We again return to our prism, ABC, which is as before placed on a supporting table. Our electric light, L (Fig. 38), must be so enclosed that only a very narrow band of light can pass out of the lantern through a narrow vertical slit. On each side of this slit we place a card, E and F. Down this narrow channel we direct a narrow ribbon-like band of strong light, which meets the prism at one side and passes out at the other. A piece of white card is held at some little distance from the prism when we get a "spectrum" band of coloured light of violet, blue, green, yellow, orange and red. Note that the violet end of the spectrum is most deflected or refracted, and the red end is least turned away from the original direction of the light.

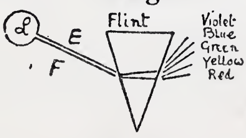


Fig. 38.

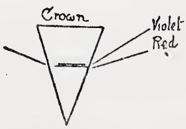


Fig. 39.

This spreading out of white light into a band of colour is spoken of as "dispersion." In a prism we have therefore two things to consider, *viz.*, refraction and dispersion, or bending and spreading. Now it has been found that if we use prisms of the same size and shape, but of different kinds of glass, we get different degrees both of refraction and dispersion. Supposing fig. 38 to represent the effect of a flint glass prism. If for this we substituted a crown glass prism the colours would be less dispersed, or, in other words, they would be crowded closer together, and also bent at a somewhat different angle, Fig. 39. Thus it is possible to combine two prisms, one having a strong refracting power with small dispersion, the other with little refracting power but strong dispersion, in such a manner that the colour-spreading action or dispersion of one prism is counteracted by the dispersion of the other, but that the refraction of the one is not entirely annulled by the other.

This may be better understood by the annexed diagram (fig. 40). Light from L meets the first prism at G. If only one prism were present this light would be dispersed between the marginal rays, GV, GR. But on emerging from the first prism it passes into a second prism of different composition and angle and reversed in position. The diverging or dispersed light is thus gathered up again and brought together at P. We thus get refraction without dispersion.

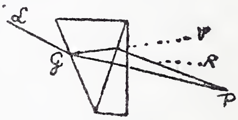


Fig. 40.

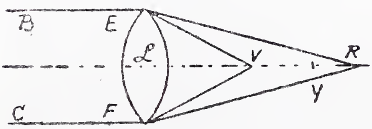


Fig. 41.

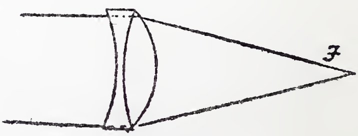


Fig. 42.

Achromatism.—We may regard a bi-convex lens as a kind of circular prism of graduated angle. If we throw a beam of white light on to such a lens composed of one piece or kind of glass, we should naturally expect to find that it would give us a

SAND-HILLS AND SUN-SHINE.

Fig. 8 (p. 5). W. A. I. Hensler.

Fig. 9 (p. 5). W. A. I. Hensler.

IN A PINE WOOD.

series of colours just like a prism. If L (Fig. 41) be a bi-convex lens and BE, CF the boundaries of a parallel beam of white light, we shall find that this white light does not come to a sharp white focus at any one point, but that anywhere between R and V we get a *more or less* sharp focus bright spot yet slightly tinged with colour. At R the colour is red and at V it is blue in tendency with a range of intermediate tints in between. But the reader has just seen in the last paragraph that by using two different kinds of glass the colour dispersion of one is counteracted by the other. Such a combination of glasses is shown in fig. 42 and they together yield a white or colourless spot of light at F. Such a combination is called *achromatic*, literally "colour free." Practically all lenses now used in negative-making have been made achromatic or *achromatized* in this way, *i.e.*, by combining two or more lenses of glasses of different dispersive and refractive powers.

Aberration.—Literally the word means "wandering," or "departure from the true path." In optics it is applied to defects due to various causes.

Chromatic Aberration.—This is the defect or failing of a single glass lens to bring all the various rays of colour of which white light is composed to a sharp colourless focus (fig. 41). The reader must not assume that because a photographic lens looks as though it were made of one piece of glass that this is the case. For when the two glasses are properly fitted together and cemented it is very difficult to recognise this without removing the lens from its cell or holding rim and examining its edges.

On the other hand, we may use in the camera for the purpose of negative-making a cheap (sixpenny) single, uncorrected or "spectacle" lens, and with it get a *fairly* "sharp" ground-glass image which shows very little signs of colour fringes. On development it is probable that our negative will not be quite so "sharp" as the ground-glass image led us to anticipate. The reason is that when focussing for the sharpest picture the eye is most attracted by and regards as brightest the yellow region of the colour band Y (see fig. 41); whereas the most chemically active rays are those near the violet

region V. But in an achromatic lens the visible and actinic or photographically active rays are brought together (fig. 42).

Spherical Aberration.—We may presume the surface of our lens to be part of a spherical surface. Such a surface is not the ideal for a lens: but the ideal surface would be vastly difficult to make. Therefore the spherical form is practically universal. But it brings certain defects in its train. One of these is that the central part does not focus the image at the same place as the outer part of the lens does. An experiment will make this clear. Take the lens of largest diameter at hand; a hand reading glass will serve quite well. Cut out a disc of black or opaque brown paper, just large enough to fit the glass of the lens, A (fig. 43). Divide the radius, PQ, into about three equal parts at R and S. With centre, P draw a circle of radius, PS, and cut the paper along this line. Now set up the lens with a candle flame on one side and a white card screen on

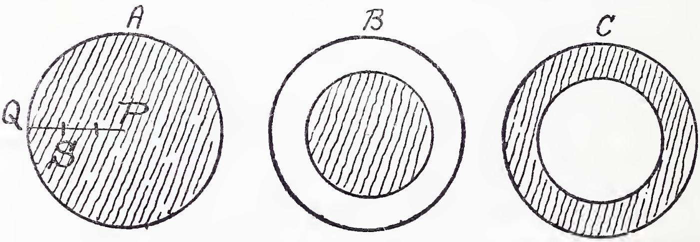


Fig. 43.

the other. With a drop of clean water fix the disc of paper, B, to the centre of the lens, and with the uncovered margins of the lens only get the sharpest possible focus. Then, without disturbing the position of the lens, remove the central disc of brown paper, and replace it by the ring or annulus of paper, C, which leaves the centre of the lens uncovered. Note that the image formed by the central portion of the lens is (with the lens in its present position) not so sharp as when the image was formed by the outer part of the lens; but we can easily get it as sharp by shifting the lens a little, *i.e.*, by increasing the distance between the image and lens. Now why is this? Let us go back

again once more to our little prism, ABC, fig. 44. Place one pin at P, another at Q, near the base, BC, of the prism, and a third pin, R, near the apex, A, of the prism. Continue the base line BC, and then find the point, T, in this line, which falls behind the pin, Q, when viewed from P, and also the position, S, on the base line, which falls behind R when viewed from P. We can thus see at a glance that a ray of light travelling along PRS is more bent or refracted than the ray, PQT, and the reason is PR makes a more acute angle with surface of AB than the ray, PQ, makes with this surface. If for the prism we substitute a lens such as that shown in the fig. 45, we find this difference of angle is still more marked.

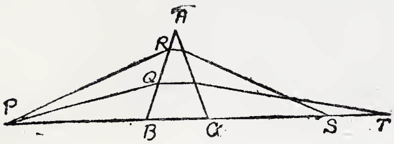


Fig. 44.

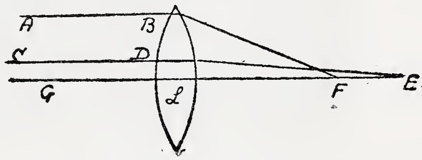


Fig. 45.

If L be the bi-convex lens and AB the marginal ray of a beam of light parallel to the axis, GE, of the lens, then AB after passing through the lens meets the axis at F. But a similar parallel ray nearer the axis meets the prolonged axis at E, the reason being, as just stated, that AB and CD meet the spherical surface of the lens at different angles. Hence their failure to come to a focus at the same point is called *spherical aberration.*

The modern arts of the optician have enabled him to overcome the effects of spherical aberration. A lens corrected for this error or defect is said to be *Aplanatic.*

Formation of an Image by a Lens. We have left this matter thus late in our experiment because the reader no doubt is fully familiar with the practical fact, and has some rough idea as to how it comes about. But we may now look at the matter a little more closely in an experimental mood. Let us set up our single lens once more and arrange the candle flame and its image as in our several previous experiments. Now take a piece of card and punch in it a hole of say ¼ inch

diameter, and put this card close to lens, on the candle flame side and so that the hole is opposite the centre of the lens. The image is not altered in size, but is reduced in brightness. By means of another small piece of white card we can track the course of the light after it has emerged from the other side of the lens and we shall find that from the candle flame to the image its course is straight, and is of the nature of a cone with its base towards the lens. Now shift the first card about so that it is in front of first one part and then another of the lens. Again we get in each case a cone with its base towards the lens and apex at the image. Now in our card let us punch a second similar hole at a distance from the first about half the diameter of the lens. The light passing through the two holes may be traced by the small card and seen to meet at the image as indicated in fig. 46. So far we have assumed that the object (candle flame) is situated on the axis, A B, of the lens.

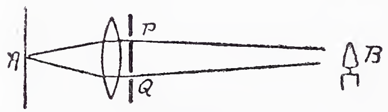


Fig. 46.

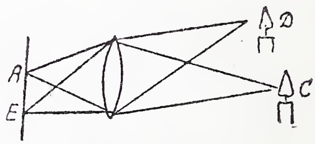


Fig. 47.

But now let us slowly move our candle flame C away from the axial line, A B, of the lens until it is at some such position as D, fig. 47, and at or about the same distance from the lens as before. As we move the flame we shall notice that the image moves in the *opposite* direction and that this is the case whether we use the whole lens for forming the image, or whether we hold the card (with one, two or more holes punched in it) close in front of the lens. A glance at fig. 47 will at once explain why our ground-glass picture is upside-down as compared with nature, and also how each point or portion of the object, C, D, etc., has its corresponding point A, E, etc., on the ground glass.

While on this topic another may be noted. Suppose A and E are the two points of the image corresponding to the two points, C, D, of the object (fig. 48). Now suppose we retain the same distance between C and D, and yet move them further away from the lens (fig. 49). This will obviously diminish the angle, DLC, and consequently bring the points, A, E, nearer together on the ground glass. Moreover, when the object is moved further away the ground glass is moved towards the lens; this, again, reduces the distance between A and E. Thus we see that the size of an image formed by the lens depends upon the distance that object is from the lens.

Fig. 48.

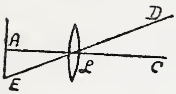


Fig. 50.

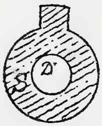


Fig. 49.

Stops and Diaphragms. — Unfortunately these two terms are somewhat indiscriminately used as synonymous by photographers. Every reader of these pages is doubtless familiar with what he is accustomed to call the stops of his lens. Properly speaking, the stop is the metal or other opaque material, S, which *stops the light*, while the diaphragm is the circular opening, D, which permits light to pass through it. Thus, when a photographer speaks of a "small stop" he means a small diaphragm D in the stop S, fig. 50.

Use of Stops.—Primarily the use of a stop is to cut out, stop, or prevent certain rays from reaching the lens, or, after they have passed through the lens, prevent them reaching the plate. We may do this either to reduce the quantity of light, or because these rays do not come to a focus with some other rays.

Let us revert to our single lens again, arranging the candle flame and image along the axis as before.

We know that for each distance of the candle there is the corresponding conjugate distance of the image. Suppose now we have two candle flames one more or less behind the other, as at A and B (fig. 51), and suppose that we get sharp images of these with our focussing screen at *a* and *b* respectively. But at no position between *a* and *b* can we get both images quite sharp. Now, in a

Fig. 51.

piece of card cut a circular hole having a diameter about one-third or one-fourth that of the lens. Placing this an inch or so either before or behind the lens, find the position of the focussing screen, say *c*, where both images are equally sharp. Without disturbing any other parts of our apparatus remove the card stop. We shall now find that neither of the images is as sharp as they both were when the card stop was in use. Now take a third candle, and move it about between A and B until in some such position as C it gives a sharp image on the focussing screen at *c*. We thus see that by cutting out the marginal rays, and using only the more central part of the lens we get what is called "depth of focus," but is better named as "depth of focal field." The reader will, no doubt, have noted during this experiment that the introduction of the card stop made a considerable difference in the brightness of the image. Hence it is that the use of a small diaphragm, while giving us additional "depth," necessitates longer exposure.

Curvature of Field.—For our next experiment some little extra care will be needed as to the placing of the various parts of the apparatus. A good-sized dining-room table will form a convenient base for the operations. It is presumed that the reader has formed by previous experiments some approximate idea as to the focal length of the lens in use. He must also now be warned that he must not use a modern flat field lens for this experiment, for the obvious reason that it has been corrected for the error we are about to demonstrate. It will be quite suitable to use our reading glass or any

Fig. 10 (p. xiv.) W. H. Nithsdale.

Playtime.

Fig. 11 (p. xiv.) E. S. Maples.

REFLECTIONS.

other single glass bi-convex lens, or the half of an old-fashioned doublet. Place a candle, A, Fig. 52, on the axial line at a distance of about three times the focal length of the lens and find the image at *a*. Now lay a thread, *tt*, on the table exactly at right angles to the axial line, A*a*. Then take a second candle, B, and move it along the thread line, *tt*, noting that its image, *c*, gets less and less sharply defined as the distance between A and B is increased. Leaving the second candle at B, take a small piece of white paper and find the position, *b*, when the image of B is sharply defined. If B be moved still further away from A along the line *tt*, then the image *b* will be found further in front of the focussing screen. Thus as B travels from A, the positions of the image would form the dotted curve *a b*. Thus with an uncorrected lens the image of a flat surface perpendicular to the axis of the lens is not in turn a flat surface, but a curved surface which is more or less saucer-like, with concave side towards the lens.

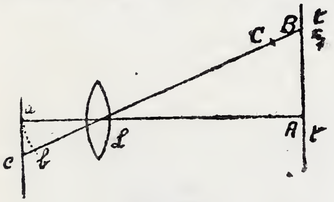


Fig. 52.

Hence the focal field is curved, or we have it otherwise expressed as curvature of the field. And although we cannot bend our glass plate into this shape, we can sometimes alter the position of the objects to be dealt with. If our second candle now at B be moved towards the lens along the line B L, and the image *c* be watched, we shall presently find some such position of the candle as C when the image *c* is as sharp as the image *a*. Hence it is that in the "good old days" when all lenses had curved focal fields it was the general custom to arrange the sitters of a group in a crescent-like manner, always uncomfortably suggestive of the opening chorus of the negro minstrel troupe.

Many modern lenses are practically free from curvature of the field. They are then said to have a flat field.

Distortion.—It is not very easy to show this without the aid of a lens fitted to a camera with ground-glass focussing screen. But the reader may very easily get a good idea of its nature by the following simple experiment. Lay the right-angled corner of this page flat down on the table.

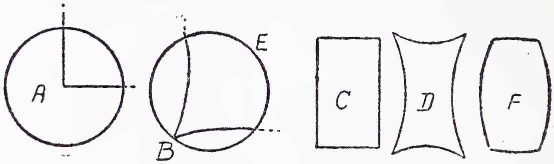


Fig. 53.

Hold an ordinary thick magnifying lens or reading glass, or other concave single lens near to the eye and also over the corner of the page so that the corner is opposite the centre of the lens, A (fig. 53), noting that it looks like a right angle. Now move the lens so that the corner of the paper comes up to and under the edge, B, of the lens, and at the same time move the eye to the opposite edge, E, of the lens and look obliquely through the lens. The right angle of the paper will seem curved and also pointed, as shown in fig. B. Distortion in the photographer's sense means that straight lines in nature are rendered as curved lines in his negative. A lens free from distortion is known as a "rectilinear" lens. If a rectilinear figure such as C, fig. 53, be drawn on paper and a "single" lens be used to bring the figure to a focus so that the sides of the figure come within, say, half an inch or so of the edges of the ground glass, we shall probably detect one of two kinds of distortion which are exaggerated in figs. D and F. If the stop or diaphragm be between the lens and focussing glass, the distortion will be of the pin-cushion kind, such as that in fig. D—but if the same lens be now turned round so that the stop is between the lens and object the distortion will be barrel shaped, as shown in fig. F.

Astigmatism.—The following experiment may serve to give the reader some idea of what this is in effect. Arrange matters as for the "curvature of field experiment" (fig. 52), Take an old dense

negative and with an old knife or stout pin scratch a couple of clear vertical straight lines, MM, about half an inch apart and about as wide as an ordinary pin. Across these at right angles scratch two other straight lines, NN. Now set up this scratched negative in a vertical plane (parallel to the focussing screen), and move it along the line *tt*, so that its image comes close to the edge of the focussing screen, and the further it is from A the better for our experiment. (Of course a lighted candle must be placed close behind the clear lines scratched on the negative.)

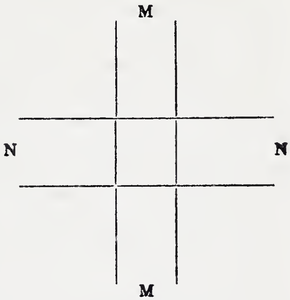


Fig. 54.

Now focus the lens for the vertical lines MM, when it will be observed that the horizontal lines are not so sharp. If we focus for the horizontal lines, the vertical ones are put somewhat out of focus. For this experiment we may use almost any kind of convex lens, except it be of the modern kind which has been especially corrected for this defect. Such a lens is known as "anastigmatic," "holostigmatic," "orthostigmatic," etc., *i.e.*, free from astigmatism.

Practical Points for Lens Users.

FORMS of Lenses.—We may comprehensively, if somewhat loosely, define a lens as a transparent body—liquid, solid or gas—bounded by at least one curved surface. For all ordinary photographic purposes the curved surface used is that of a sphere. We shall therefore leave aside for the present all consideration of lenses bounded by other curved surfaces, such as cylinders, ellipsoids, paraboloids, etc.

Suppose then that we have a solid ball or sphere of glass and cut it by a plane into any two parts. Each portion is now bounded by a plane surface and a spherical surface. We thus have two "plano-convex" lenses. Note that where the edge of the curved and plane surfaces meet we have a circular boundary to both the flat and curved surfaces. Before making the cut imagine a straight line drawn through the centre of the sphere and the centre of this flat plane with a circular edge. This line is the axis of the lens.

The Parts of a Photographic Lens.—Strictly speaking, the glasses only are the lenses, but we photographers are accustomed to use the word lens to include both glass and brass.

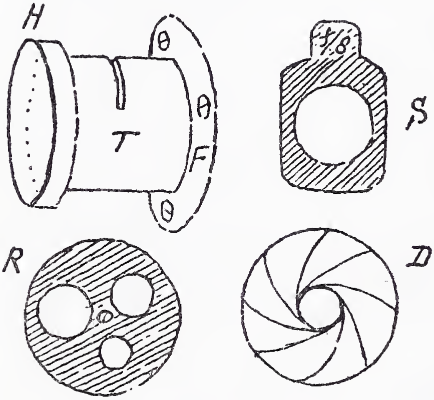


Fig. 55.

An ordinary lens consists of a "*flange*" or metal ring, F., fig. 55, which is screwed to the front of the camera. Into this ring is screwed the "*lens tube*," T. At the other end of the tube is a short and somewhat larger tube called the "*hood*," H. On this fits the lens cap (not shown). The object of the hood is to shield the lens from injury, and also to prevent such rays of light falling on the lens as are not required in the formation of the picture image. In the lens tube is a "slot." Fitting this slot is a series of "Waterhouse" diaphragms or stops (so named after their originator). These stops, or thin pieces of metal, all have the same external dimensions, but vary in the size of the circular aperture or diaphragm. In place of separate stops some lenses are fitted with a circular piece of metal, in which are pierced holes of various sizes, which can in turn be brought

inside the lens tube by rotating the apparatus about a pivot inside the tube. Hence these are known as rotating stops. The third and now very generally adopted system is known as the "iris" or ring diaphragm. By moving a rotating ring of metal clasping the lens tube a number of somewhat wedge-shaped pieces of metal are actuated together and, according to the position of the rotating ring outside the tube, so depends the size of the hole left open by these overlapping leaves of metal.

(a) Waterhouse stops are easily lost or bent.

(b) The rotating diaphragm is somewhat bulky.

(c) The overlapping metal leaves in time wear bright, and give rise to flare or other undesirable images. But, all things considered, c is the best system. G.D.

The Focal Length of a Lens.—For the convenience of ready reference we bring together a few simple methods of ascertaining the focal length of a lens, or system of lenses. But first let us explain what is meant by the focal length, or more correctly the "equivalent focal length" of a lens.

No. 1. Suppose the lens or system of lenses to be adjusted to give a sharp image of some distant objects, for example, say two tall factory chimneys a mile away from us. Suppose these are just 2 inches apart on the ground glass. The lens system is removed and its place taken by a single bi-convex lens of extreme thinness, such that it gives us a sharp image of the same tall chimneys, and shows them as before exactly the same distance, *viz.*, 2 inches apart. The size of image given by the two experiments is the same, or the single lens is in this respect *equivalent* to the first-named lens or system of lenses. The second (single) lens is supposed to be of negligible thickness so that we can the more accurately measure the distance between the ground glass and this extremely thin lens. This distance would be the *equivalent focal length of the system.* This method is theoretical rather than practical, but it suggests a practical modification which is often very useful.

This is based on the principle that when dealing with distant objects the size of the image is proportional to the focal length of the lens.

Suppose then we have observed that with the lens to be measured, the size of a distant object or distance between two distant objects, as before mentioned, is 2 inches on the ground glass. Now remove this lens and replace it by a single plano-convex lens having the curved side* towards the ground glass and again focus the distant object as sharply as possible, and suppose the distance between the chimneys is now three inches. Measure the distance between the ground glass and centre of the curved surface of the lens. Suppose this to be 12 inches; then by the laws of proportion the second distance, 3 inches, is to the second focal length, 12 inches, as the first distance, 2 inches, is to the first focal length, or 3 : 12 :: 2 : 8; *i.e.*, the focal length of the first lens would then be 8 inches.

2. In place of the thin single lens let us use a pin-hole of about $\frac{1}{40}$ inch diameter and so adjust matters that the tall chimneys are again 2 inches apart. We can now easily measure the distance between the ground glass and pinhole. This gives us the equivalent focal length required.

3. Select a window from which some well-defined distant object, such as a factory chimney, telegraph post, or church spire may be seen. Place a small table before the open window and on the table pin a sheet of white paper. Now set up the camera and focus the distant object and arrange so that it falls about half an inch from one side of the ground glass. Fix its position by a mark on a bit of gum paper. Now draw a pencil line A B along one side of the camera. Next, without disturbing the table or paper, rotate the camera so that the image of the same chimney, etc., now falls about half an inch from the opposite side of the ground glass. Now measure carefully the distance on the ground glass between the first and second positions of the object. Suppose this is six inches. Then, without disturbing the camera, draw the line A D along its edge resting on the

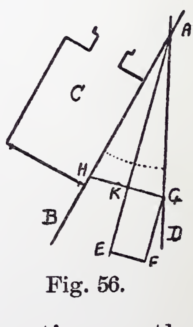


Fig. 56.

* *cf* p. 49.

Landing Mackerel.

Fig. 12 (p. xiv.) C. B. Alexander.

paper as before. The camera may now be removed. Now bisect the angle B A D by the line A E. Then draw E F perpendicular to E A and make E F three inches, *i.e.*, half the distance between the two different positions of the images on the focussing screen. Then draw F G parallel to E A. Finally, draw G K H perpendicular to A K. Then A K is the focal length of the lens. In practice this is a very simple and accurate method, though the description reads somewhat complicated.

(4) This method is a modification of that just given. Focus the lens for a distant object, and mark on the base-board (at the back or front as the camera focusses at the back or front) this position for distance. Now draw across the middle of the ground glass a horizontal straight line and find its centre, A. Then at equal distances to the right and left and as near to the margin of the ground glass as convenient make two marks, B C., fig. 57. Lay the camera on a sheet of card and place a candle or lamp flame not nearer to the lens than fifty times its focal length. Arrange the image of the flame to fall at A and be in sharp focus. Carefully note the distance, A K, that the camera has to be extended from its position when "distance" was in sharp focus. Draw pencil lines on the card along the straight edge of the sides of the base-board C E, B F, and also along the back, C B, without disturbing the card rotate the camera so that the candle flame falls on the mark, C. Draw another straight line on the card along the side of base-board, L N. Again repeat by bringing the candle flame to the corresponding opposite point, B, on the ground glass and draw the third line, L M. Draw A L midway between and parallel to C E and B F. Mark off A K equal to the alteration of the camera extension from distance to adjustment for the candle. Then K L is the focal length required.

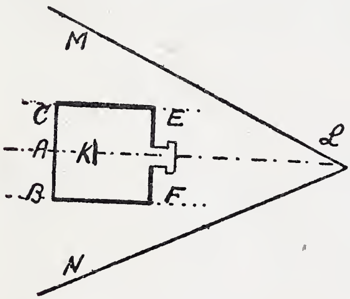


Fig. 57.

(5) Focus any object, such as a foot rule, and arrange the inch marks of the object to occupy exactly one inch apart on the ground glass (*i.e.*, the object is the same size as the image). Then measure the distance between the object and the image. The focal length is one-fourth part of this distance (approximately).

(6) If the camera bellows is not long enough to give the image the same size as the object, we can modify this method by arranging the image to be some convenient fractional part of the object. Thus the inch marks on the rule may be one-half or one-third, or one-fourth of an inch apart. Thus a twelve inches rule would be 6 inches, 4 inches or 3 inches, etc., on the ground glass. Now measure the total distance between the ground glass and object, and consult the following table.

Ratio of object to image	equal	2 to 1	3 to 1	4 to 1	5 to 1	6 to 1
Factor	$\frac{1}{4}$	$\frac{2}{9}$	$\frac{3}{16}$	$\frac{4}{25}$	$\frac{5}{36}$	$\frac{6}{49}$

Example, suppose the object is 3 times the size of the image. Under the proportion 3 to 1 we find the fraction $\frac{3}{16}$. Then the focal length of the lens is $\frac{3}{16}$ of the distance between the object and image.

(7) Focus for a distant object and mark on the base-board the position of the ground glass. Now focus some near object so that the image and object are the same size. Now note how far the camera has had to be extended for this second focussing. This extension is the focal length of the lens used.

(8) The reader will probably wonder why we have not advised him to focus any distant object and measure the distance from the ground glass to the lens. But the question arises, *what part* of the lens? the back, front, middle? For rough and ready purposes it may suffice to measure to the stop of a doublet or the centre of the glass of a "single" lens.

As the sun was often used for this method of

ascertaining the focal length, the distance was sometimes called the *solar focus* of the lens. When the distance was measured to the surface of the nearest glass it was called the "back focus." This measurement is sometimes useful in camera construction.

(9) We presume that the reader understands that when the lens receives a bundle of parallel rays, *i.e.*, light coming from an object a very long way off, these rays are brought to a focus at a point called the principal focal point of the lens. And as the action of light is reversible, it follows that if a small luminous point be placed at the principal focus the lens or system will send the light forward as a parallel beam. This gives us the hint for yet another method of determining the focal length of the lens under examination. In a piece of white card cut a small hole, say, half an inch square, and stretch across this hole either a couple of very fine wires, AA, BB (such as are used by street flower vendors), or use some fine black cotton (fig. 58). Behind the hole, H, on the card, C, arrange a candle or lamp flame. Place the lens, L, opposite the hole in the card and at a distance about that of its supposed focal length. Behind the lens place a flat mirror, MM, parallel to the card, C. By very slightly tilting the lens to one side we find that it shows an image of the cross wires on the card at K. The distance between the cross wires and lens must be so adjusted that the image at K is quite sharp. Then measure the distance from the wires to the nearest node of the lens (see p. 47); this gives us the focal length. The explanation of this method is that when the cross wires at H are at the prin-

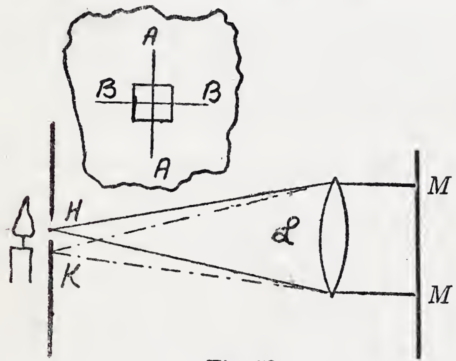


Fig. 58.

cipal focus of the lens the rays, after passing the lens, are parallel to each other and perpendicular to the mirror, which therefore sends them back again along the course they came, and the lens, when very slightly tilted, again brings them to a focus at K.

(10) One more (of the many remaining methods) may suffice to close this section. Our mathematically-inclined readers will have no difficulty in deducing it from the well-known formulæ. Others may perhaps be content to take the proof for granted and accept the method. Set up a foot-rule and focus it so that the 12 inches occupy some exact number of inches on the ground glass. Let us suppose this to be 7 inches. Call this the first image. Now put a mark on the base-board of the camera and increase the distance between the object and lens, racking the camera inwards until the image is some other precise length, say 4 inches. Call this the second image. Now note the distance travelled by the ground glass. Suppose this to be 2 inches.

Rule.—Multiply the size of the object (12) by the distance travelled by the ground glass (2) and divide by the reduction of image (7 *minus* 4 or 3). Thus $\frac{12 \times 2}{3} = 8$ inches, the focal length of the lens.

A.M.

Focal Length and Perspective.—It is a matter of common experience that a small picture, *e.g.*, quarter-plate size, made with a lens of short focus, *e.g.*, 4 inches, giving a wide angle of view when viewed by normal eyes at, say 10 inches, often conveys an untrue impression, This is especially the case with architectural interiors. The reason is that the view shows as a wider angle of scenery than we are accustomed to, and is often, but not very correctly, referred to as strained or exaggerated perspective. It is not so much the fault of the perspective, as the result of viewing the picture from too great a distance from the eye. If the reader will view such a picture through a large sized pinhole in a card held close to the eye, and at the same distance from the eye that the lens stop was from the plate in the camera, this "exaggerated perspective" effect will vanish. If

the same angle of picture be included on a 17×13 plate with a lens 16 inches from the plate, or the original be enlarged to this size, and viewed at 16 inches, a similar change of effect will be noticed.

It is often stated that a picture should be viewed at a distance from the eye equal to the focal length of the lens. But it would be better to say the viewing distance should be equal to the distance between the lens and plate, noting that this distance is frequently considerably greater than the focal length of the lens. For instance, if the image be half the size of the object with a six inch lens, the lens will be nine and not six inches from the plate. If with the same lens the image be two-thirds the size of the object, the lens would be 10 inches from the plate, etc.

Focussing Scales.—It is not advised to place too much reliance on Focussing Scales marked on the camera until they have been verified by actual observation and experiment. Nevertheless, it may be useful to give one way of marking such scales. First focus the lens for infinity or extreme distance, and mark the focussing scale at Z for infinity.

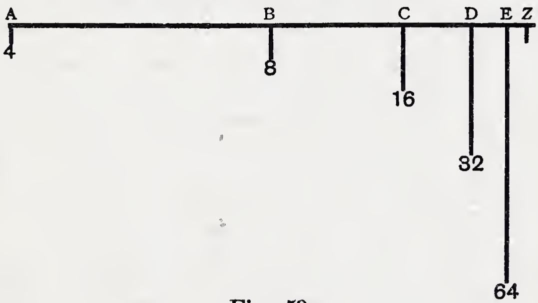


Fig. 59.

Now focus with the aid of ground glass on some small, bright object, such as a candle flame placed at 4 feet from the lens. Suppose this point is at A on the scale. Now measure the exact midway distance between A and Z. Suppose this is at B. Mark this as the focus point for 8 feet. Similarly, midway between B and Z is C, the focus point for objects 16 feet away. Again, midway between the 16 feet point and infinity point is the 32 feet point and so on.

The Aerial Image.—This, unlike the ground-glass image which can be seen with the eye in any position, requires either the eye placed in a certain position, or the aid of an eyepiece similar to the Ramsden eyepiece of a telescope. For critical focussing we abandon a ground glass, and use a piece of clear glass in its place. A fly's wing or one or two fine hairs are held against one side of the clear glass by the aid of a drop of Canada balsam, and a microscopic cover glass. (If preferred we may make a few diamond scratches on one side of the sheet of glass, and adjust our focus by aid of these scratches). The eyepiece rests on the other side of the glass, and the focus adjusted so that the fly's wing is sharply seen through the eyepiece and plate of clear glass. Then any aerial image which occupies a position on the inside surface of the clear glass will be sharply defined when examined with the eyepiece. Some experimentalists prefer to cut the sheet of clear glass into two parts, and of such a size that a clear space of half an inch is left between them. Then the edges of the eyepiece rest on the edges of the two pieces of glass, and the aerial image is thus examined without any glass between it and the eyepiece.

Fine Ground Glass.—For lens testing, it is desirable to employ the finest ground surface we can obtain. Or we may take an ordinary unexposed dry plate and fog it by striking a match in the dark-room, and exposing it for a few seconds. It is now developed to a grey thin even fog image all over; fixed; and *thoroughly* well washed. It is now bleached in a saturated solution of mercuric chloride, again well washed and dried. Ordinary grain ground glass such as is used for focussing, may be greatly improved for fine focussing by rubbing over the rough side a mere *trace* of glycerine, vaseline or olive oil.

Enlarging.*—The beginner is apt to get a little confused as to the focal length required for producing a small direct negative of—let us say—5×4 size, and an enlargement from such a negative of say 20×16 inches. He argues that if a lens of 6

*Consult *The Practical Photographer* No. 2 "Bromide Enlarging."

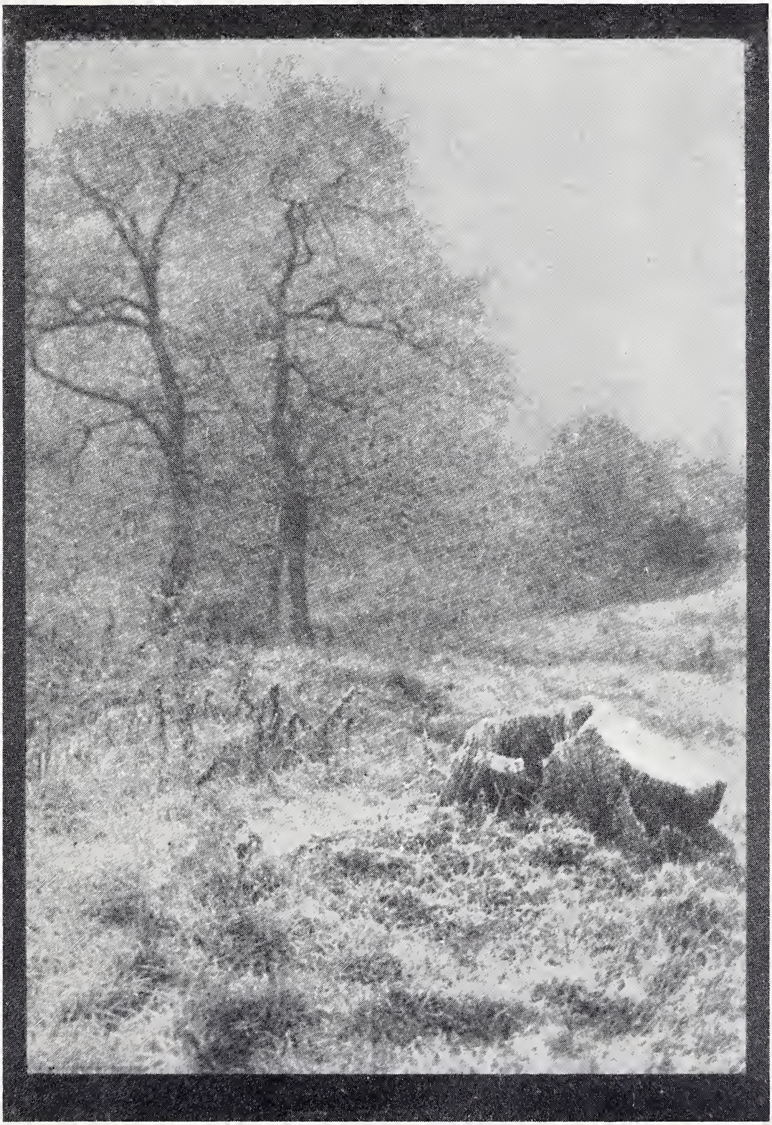


Fig. 13 (p. xiv.) J. Walton

WINTER.

Fig. 14 (p. xiv.) H. B. Cookson.

HUSHED AND STILL.

inches focus is required for the small negative he ought to have a lens of four times this focal length (24 inches) for making a picture by enlargement four times (20×16) as large. But this is not the case at all.

Suppose the original object to measure 20×16 *yards.* Light from this passes through his 6 inch lens and gives him a negative 5×4 inches. Now we have seen on a previous page (*viz.*, 16) that it is one of the fundamental principles in such optical systems as are used by photographers that the action or direction of light is reversible. Consequently we might imagine light to come from or pass through his 5×4 negative and yield him a picture 20×16 yards without altering the position of camera and lens. Thus it is not at all a question of the actual size of the enlargement, but the angle of the cones of light which have their apices or points at the lens. A lens which will produce a negative of any size will enlarge that same negative to any size again up to the size of the original object. If it be desired to use a lens other than that with which the negative was made this may be done, provided the cone or angle of the lens efficiently covers the size of the negative when the lens is at such a distance from the negative that it will be when the enlargement will be made.

B. J. D.

Aperture.—In ordinary parlance an aperture is simply an opening, but the photographer uses the term in a special sense. In the section of testing lenses, page 56, will be found a note about comparing the diameter of the diaphragm opening with the equivalent focal length of the lens. We may here assume this has been done. Let us suppose the diameter of the circular opening is one inch, and the focal length of the lens is eight inches, then this stop with this lens would be marked $f/8$. But suppose we have another lens of four inches equivalent focus, and with this we use the same piece of perforated metal with its one inch opening, this would now have a value $f/4$. Now, when speaking of stops we refer to them by their f value. So that although in these two cases we might be using two precisely similar pieces of perforated metal with the

two lenses, yet we should call them different stops, because of having different f values. In the same way when speaking of the "aperture" of a lens we do not refer to the actual size of the diaphragm or stop opening, but its size *relative* to the focal length. Thus our inch circle stop with a lens of 4 inches focus would give us a large "angular aperture" or more generally and briefly "aperture," while if used with a lens of 16 inches it would be called a small aperture.

Exposure and Aperture.—The duration of exposure varies inversely with the quantity of light. This varies directly as the square of the diameter of the diaphragm or stop opening. Hence the exposure varies inversely as the square of the denominator of the aperture fraction. For example. The exposure with $f/16$ is not double but four times that with $f/8$.

By way of example, suppose that 4 seconds with $f/8$ is a satisfactory exposure, and we wish to repeat it with $f/22$.

Then the exposures are to the proportion of 22×22 to 8×8. And the smaller stop, of course, requires the longer exposure, therefore our rule of three is:—

$8 \times 8 : 22 \times 22 = 4 :$ requires time. This works out to about something between 30 and 31 seconds.

For general convenience of reckoning most modern lenses have their stops or apertures so arranged that an exposure with any one is equivalent to double the exposure with the next smaller or half the exposure with the next larger.

They are usually marked,

$f/4$, $f/5{\cdot}6$, $f/8$, $f/11$, $f/16$, $f/22$, $f/32$, $f/45$, $f/64$.

This 6 seconds with $f/22$ is equivalent to
„ 12 „ „ $f/32$ or
„ 3 „ „ $f/16$.

The use of a diaphragm or stop.—This is twofold. Obviously a small hole admits less light than a large one in a given time. But the more important function of the stop is that of using different parts of the lens for forming different parts of the picture, *viz.*, the central part of the lens for the centre of the picture, and the margins of the lens

for the margins of the picture. The advantage of this is that the effects of spherical aberration are reduced, as may be seen, by comparing the two accompanying diagrams, figs. 60 and 61, showing the effect of a large and a small stop in the two cases.

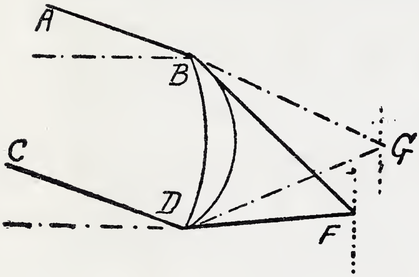


Fig. 60.

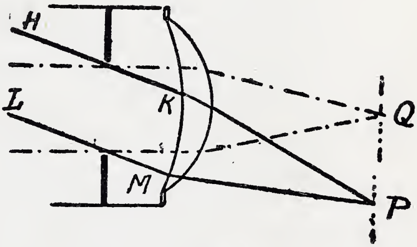


Fig. 61.

With the large diaphragm, fig. 60, the parallel marginal oblique rays, AB, CD, come to a focus at F, and the parallel marginal direct or axial rays come to a focus at G. In this case, F and G would not both be in focus on the ground glass at the same time. But with a small stop, fig. 61, the marginal oblique rays, HK, LM, are nearer together and only pass the marginal part of the lens and are brought to a focus at P, while the narrow axial rays come to a focus at Q.

Q is further away than G is from the lens, and P is further away than F, but P and Q can be focussed at the same moment, but this is not so with G and F.

If for any reason a large stop must be used then some sort of a compromise must be arrived at, and the focussing screen will probably be placed in some position intermediate between that best for F and G. Hence it follows in general that there is a best position of the focussing screen for each stop, so that it is advisable to focus the picture on the ground glass with the stop with which the exposure will be made, and not to focus with one stop and make the exposure with some other. F.A.H.

Angle of View, and Wide-Angle Lenses.—Imagine a bell-shaped tent resting on the ground, supported by a vertical tent pole. We can imagine it possible

to spread on the floor a square blanket whose corners just reached the circular edge of the tent. We could replace this by an oblong blanket which again just reached the margin of the tent. In each case the central tent pole would come in the middle of the square or oblong blanket.

Again, we could lay on the ground a blanket much smaller than either of the two first used and put it so that two corners only touched the tent margin, or we could have part of this smaller blanket outside the tent.

Now we may compare the cone of light which passes through our lens and spreads out inside the camera to the bell tent, the lens corresponding to the top of the tent pole, and the pole we may regard as a magnified axial ray of light.

The blanket spread on the ground is, of course, our photographic plate. The *angular* size of our tent or cone of light we may measure by comparing the width of the circle with its distance from the apex or lens. If we elevate our tent pole and yet retain the same size of ground covered, we get a smaller, narrower angle of the cone at the top of the pole. This corresponds, of course, to increasing the focal length of the lens.

In our camera we may be using, say, a lens of ten inches equivalent focus. With this we may make a whole-plate, half-plate, or quarter-plate negative. Clearly we shall get three different quantities of subject or angles of view, the larger including the smaller.

Wide-Angle Lenses. The largest rectangular figure that we can inscribe in a circle is a square, fig. 62. Therefore the maximum view angle with any lens would be obtained with a square plate. But custom and convenience have settled that most of our plates shall have their sides in the proportion of *about* 4 to 3, *e.g.* the $\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{1}$, 12×10, etc.; we therefore seldom use the maximum angle of a lens. Again, it often happens that it is not convenient to use the lens with the optic axis in the centre of the plate, but raised or lowered. Raising the lens raises the cone of light from the position of the continuous line (Fig. 63B) to the position of the dotted line. So that if the corners of our

plate are not to be "cut off," *i.e.*, uncovered by the cone of light, we must use a plate somewhat smaller than that possible when the optic axis is central. This, of course, is reducing the angle of view.

Hence it will appear that a so-called wide-angle lens can under certain conditions only be used as a narrow-angle lens. For instance, when the user is employing a rising, falling or cross front. Thus we may say that a wide-angle lens can always, if required, be used as a narrow-angle lens, but not *vice versa.*

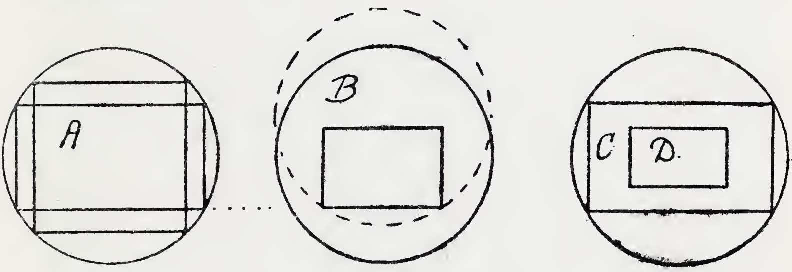


Fig. 62. Fig. 63. Fig. 64.

Fig. 62 shows that the largest area of plate covered by a lens is square in shape.

Fig. 63 shows that raising the lens (which brings the cone to the position of the dotted circle) necessitates a smaller than the maximum-sized plate being used.

Fig. 64 shows that a wide-angle lens can be used to give a wide-angle or narrow-angle picture, according to size of plate used. R.D.

Measuring the View Angle.—It is customary to measure this by comparing the longest side of the plate used with the distance between the lens and plate. For the benefit of the non-mathematical reader we give a short table which will enable him, with the aid of a tape measure, to see at a glance what is the angle of view of his picture.

(1) Measure the long side of the plate (say 12 inches) and divide this by 2 (thus getting 6).

(2) Measure the distance between the plate and stop of the lens, say 15 inches.

(3) Divide the half length of plate (6) by the lens distance (15). This gives us ·4. Refer to the first column of the table and opposite ·4 we find 44 degrees of angle.

One more example: *e.g.* the case of a $5\frac{1}{2}$ inch lens with $4\frac{1}{4} \times 3\frac{1}{4}$ plate. Dividing the half of $4\frac{1}{4}$ by $5\frac{1}{2}$ is the same as dividing $4\frac{1}{4}$ by 11, or $8\frac{1}{2}$ by 22, or 17 by 44, we get approximately ·39. The nearest in our table to this is ·4, which corresponds to 44 degrees of angle. Thus we see that a $5\frac{1}{2}$ inch lens will give us practically the same picture or view angle as a 15 inch lens with a 12×10 plate.

Table of View Angles.

(Approximation.)

Quotient	Angle	Quotient	Angle	Quotient	Angle
·1	11°	·5	53°	·9	84°
·15	17°	·55	58°	·95	87°
·2	23°	·6	62°	1·0	90°
·25	28°	·65	66°	1·25	103°
·3	34°	·7	70°	1·5	113°
·35	39°	·75	74°	1·75	120°
·4	44°	·8	77°	2·0	127°
·45	48°	·85	81°		

Size of Angle and Length of Focus.—These two properties are often confused, and some workers think that a lens of short focus necessarily has a wide angle. This is not the case. But of course a lens of certain focal length, *f*, which just covers a certain plate, A B, has a wider angle than a lens of the same focal length, *f*, which only covers a smaller plate, C D, as we can see at a glance from the figures below.

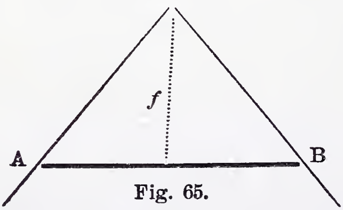


Fig. 65.

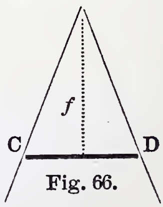


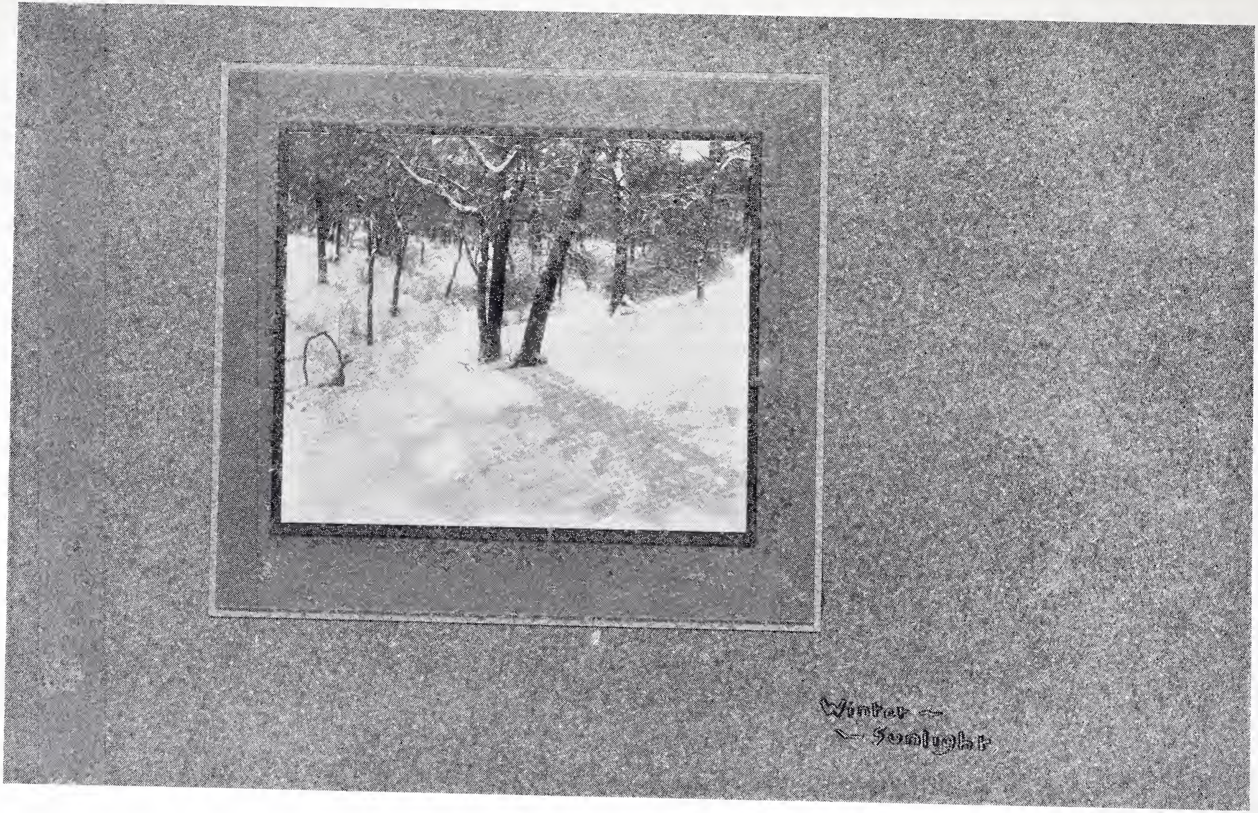
Fig. 66.

What is a Wide Angle?—The answer to this is like that to the question, "What is a large stone?"

Fig. 15 (p. xiv.) D. W. Elliott.

THE
KNITTING
LESSON.

Fig. 16
(p. xiv.)



J. Dunlop

One cannot profitably draw hard and sharp lines of demarcation between narrow, medium and wide-angle lenses but general parlance would say that a lens of focal length equal to $1\frac{1}{2}$ times the long side of the plate was a medium angle of view. If the focal length is less than the longest side, it may be spoken of as a wide-angle lens for that plate. If the focal length is two or more times the long side of the plate, it would be generally regarded as a narrow angle under the circumstances. Thus a lens of 10 inches focus with a 12×10 plate would include a wide angle. The same with an $8\frac{1}{2}\times6\frac{1}{2}$ plate a medium angle, and with a $4\frac{1}{4}\times3\frac{1}{4}$ plate, a narrow-angle picture would result. M.B.R.

To Ascertain the Conjugates of a Lens without Calculation.—It is now assumed that the reader understands the term conjugates (page 13), and has ascertained the equivalent focal length of the lens under consideration. Obtain a large sheet of card,

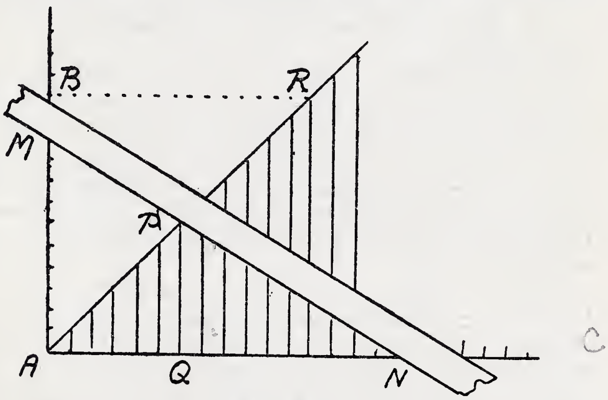


Fig. 67.

having two (at least) of its edges, AB, AC, exactly at right angles, fig. 67. Mark off each side in inches, measuring from A in both cases. At any (the same) distance, say twelve inches from A, along AB and AC, draw lines parallel to these lines. Suppose these lines just drawn to meet at R. Join OR. Then OR bisects the right-angle at R. From the inch marks along AC, draw lines parallel to AC, and just long enough to meet AR. We now

require a stout pin, and a fairly long straight ruler, *i.e.*, about the length of the diagonal of the card.

To use the method, read off along AN the number of inches of the equivalent focal length of the lens. Let this be AQ. Follow the vertical line at Q until it meets the diagonal AR at P. At P insert the pin; now bring the straight edge, MN, to rest against the pin P, and overlay the sides AB, AC, meeting then at M and N. Then if AM is one conjugate, AN is the other in any position of straight edge when resting against the pin P.

The Simple or "Spectacle" Lens.—It is not a little unfortunate that the phrase single lens is used by photographers in two such different senses that confusion frequently arises.

1. It is used to denote a lens consisting of *one piece of glass only*, such as is commonly used for eye-glasses or spectacles, and hence the term "spectacle lens" is also used in this sense. But as such lenses are often other than could be used in spectacles, it would seem desirable to substitute the term *simple* lens.

2. Lenses are made for photographic and other purposes which are composed of two or more pieces of glass, and either cemented together or mounted close together in one cell. The ordinary observer usually cannot tell if such a so-called single lens is made up of more than one piece of glass, though he may suspect this to be the case from the use to which it is put.

Between these two uses (1 and 2) of this expression, confusion easily arises. Here for the moment our attention is concerned with the single or spectacle, otherwise simple lens of the first section. From manufacturing opticians such lenses may be bought for about 6d. apiece, and we have a considerable range of focal lengths to choose from. We can have plano-convex, bi-convex, plano-concave, bi-concave and meniscus forms.

For the purpose of negative making the meniscus has the balance of advantages. Let the reader invest in such a meniscus (or periscopic lens, as it is likely to be called by the vendor), of 6 or 8 inches focus. A little ingenuity and a couple of pieces of cardboard tube will enable him to mount this into

the ordinary flange of his $\frac{1}{4}$-plate camera. Then let him verify by personal experiment the following statements.

1. Arrange the lens with the *concave* side towards the plate. It will be easy to get a moderately sharply-defined picture in the centre of the ground glass, but the other parts will be noticeably out of focus.

2. Arrange the lens with the concave side towards the object. Now, although the centre of the picture is not quite so sharply defined as before, yet the *difference* between the definition of the various parts of the picture is not so great as before.

3. Arrange a third tube of card to slide in the front part of the other tubes, and across the inner end of this fix a diaphragm or stop of blackened card. Make the diameter of the stop opening about one-tenth the focal length of the lens. Place the stop about one inch away from and on the object side of the lens. The image is now improved in definition generally. Now increase the distance between the lens and stop: the definition is improved.

4. Under the above conditions it will be noted that when the stop is *about* two inches away from the lens it begins to cut off the light from the corners of the focussing screen. Therefore there is a practical limit of distance between stop and lens for each set of conditions.

5. Having selected some fairly distant subject, such as an open landscape, and got the best possible general definition, expose a plate in the ordinary way. On printing the resulting negative it will be found to be less sharply defined than was the corresponding ground-glass picture, because the chemical and visible rays do not agree in position, *cf* p. 18.

6. Repeat experiment 5, but before exposing the plate rack in the lens nearer the plate (*i.e.*, after focussing) for about $\frac{1}{40}$,* the focal length of the lens. In the case of an 8 inch lens this after adjustment may just be under $\frac{1}{5}$ inch. The resulting negative

*This proportion must be increased to about $\frac{1}{25}$ when the image is the same size as the object.

will be markedly sharper than that resulting from experiment 5.

7. Revert to experiment 5, but fit a cap of deep blue violet glass on to the lens tube and focus with that in position. Remove the coloured glass, inspect the ground glass and expose a plate with altering the focus. The negative is again sharper than the image as seen on the ground glass.

A battery of such simple lenses of different foci is of considerable value to the pictorial landscape worker, as it enables him to include just as much subject as he wishes and yet to fill his plate. For the half-plate worker we recommend the following foci: 6, 8, 12, 16, 24 inches. Before being at the trouble to mount the 24 inch lens he should satisfy himself that his camera will give him a range of say 24½ inches between lens and plate, so that he may, if need be, deal with objects as near as 100 feet distance.

Single Achromatic Lens.—Here we refer to those of class 2, p. 44. These are properly corrected for chromatic aberration and may be confidently recommended to the notice of all kinds of out-door work (especially trying cases of architecture excepted) and also for portraiture where soft and pictorial results are desired. The single achromatic lens has the advantage of having only two surfaces of glass to give reflections, collect dust, or tarnish. In some of the modern doublets we may have as many as 6 (and possibly more) reflecting surfaces. Each reflecting surface means a loss of light and the danger of such troubles as flare or ghost images (p. 64). A single achromatic lens with a somewhat deep concave side (turned towards the object or landscape, of course) possesses a depth of focal field considerably beyond what one might anticipate, especially when used with a moderately small stop rather near the lens.

When two single lenses are mounted into one tube to form a system it is often called a doublet. If they are precisely similar, we have a symmetrical lens. If three single lenses enter into the system it may be called a triplet. W. H. R.

Uncementing and Cementing Lenses.—The Canada balsam used to cement the two glasses of a lens

together may turn yellow if exposed to light, or it may exhibit tree, or leaf-like markings, which interfere with the best performance of the instrument. In this case the lens has to be uncemented, cleaned, and recemented with colourless balsam. Whenever practicable, this should be entrusted to a skilled optician, but for the benefit of the careful worker out of reach of skilled aid, we may explain how the work may be done, premising that great care must be taken in handling the glasses, and replacing them in exactly the same position.

Line the bottom and sides of a small saucepan with a couple of thicknesses of old blanket. Remove the lens from the cell, and put it in the saucepan. Cover to a depth of a couple of inches with cold water.

Put the saucepan on the oven top, and *slowly* heat until the water is just as hot as the hand can bear it. Lay a couple of thicknesses of blanket on the table. Remove the lens and separate the glasses by a twisting motion. This should not be difficult now if slowly done, care being taken to avoid dropping the glasses, although the precaution of the blanket on the table is present. Now clean away the old balsam with soft rag and ether, chloroform, or pure alcohol. Lay the separated and clean glasses on a sheet of clean white paper to cool. Dissolve a little Canada balsam in about double times its bulk of alcohol or chloroform. In the centre of the concave side of a pair of glasses fitting each other, put one good-sized drop of balsam solution. Bring down upon it the companion convex surface, and let the weight of one glass press evenly on the other, and lay aside in a warm, but not hot, place. Any surplus balsam which oozes out between the edges of the two glasses is removed with a knife blade, followed by a rag moist with alcohol. A dozen pence are wrapped up in clean paper, and laid on the lenses as a pressing weight for 24 hours, and then the lenses are returned to their cell.

To find the Nodes or Gauss Points of a Lens.—Take the lid of a small and fairly deep quarter-plate cardboard box and cut out curved pieces from each end so as to support the lens tube, fig. 68. Down

the centre of the inside of the box rule a straight line. (In the diagram we have torn away one side of the box to show this line as a row of dots). Rest the lens tube on the curved cuts of the box, and focus a bright distant object on a sheet of white card. Put a short pin at some point of the ruled line, and pass it through the box to the supporting table. This pin forms a pivot, about which the box and lens may be rotated from side to side. As the lens is rotated the image is watched and the position of the pivot pin moved until the image remains stationary, when the lens is moved. The pin is now underneath one of the nodes. The lens is now turned right round (through two right angles) and the position of the pin changed as required, when the other node is found in the same way. When the lens is in the camera receiving light from an object, the light passes through the lens *as though it were* converging to meet at the "*node of admission*," (but it does not actually pass through this point), and on emerging from the lens (or lenses) of the system it behaves *as though* it had skipped from one node to the other node, and were originating from this second node. The focal length is measured from the "*node of emergence*" to the position of a sharp image of a distant object. Until comparatively recently it was thought correct to measure the focal length from the stop of a doublet or optical centre of a single lens.

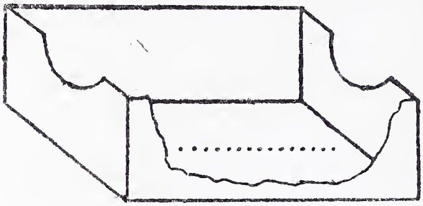


Fig. 68.

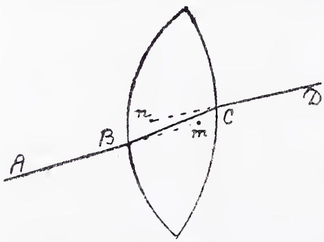


Fig. 69.

In fig. 69 light is supposed to meet the lens at B in the direction A to B, be refracted at B along BC, and again be refracted along CD. The nodes

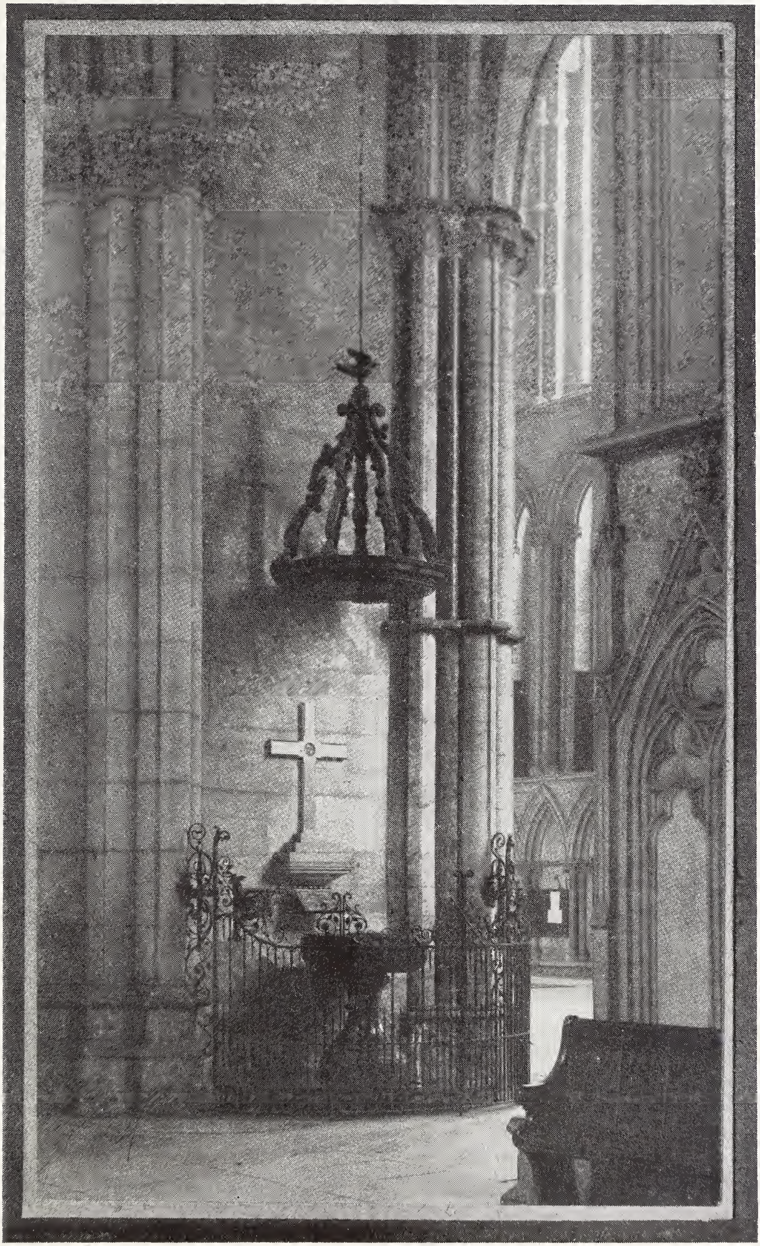


Fig. 17 (p. xvi)　　　　B. Jackson.

I am The Way
The Truth,
and The Life.

are at *m* and *n*, *i.e.*, where AB and CD, produced meet the axis of the lens. G.S.

The Optical Centre of a Single Lens is found by drawing AB and CD two parallel radii from the centres of curvatures, A and C, to the surfaces of the lens, B and D, joining the points, BD. The point where the line BD cuts the axis being the optical centre, figs. 70 to 73. The optical centre of a bi-concave or bi-convex lens is inside the glass, in a meniscus it is outside, and in a plano-concave or plano-convex it is where the axis cuts the curved surface.

Usually the optical centre is between the nodes, fig. 69.

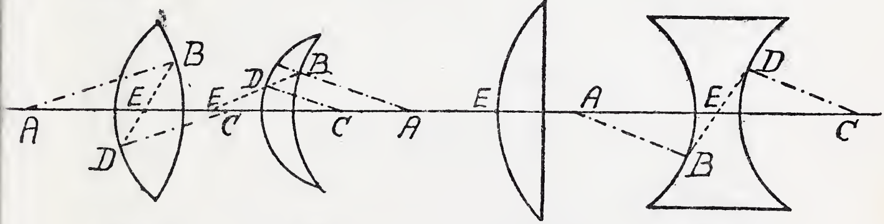


Fig. 70. Fig. 71. Fig. 72. Fig. 73.

Register.—Here we use this term to signify that the film side of the sensitive plate in the double back or sheath must, when in position for exposure in the camera, occupy the exact place that the rough side of the ground glass occupied when focussing was done. Otherwise we cannot expect the plate to register in one position the image arranged on the ground glass in another position. This may be verified by one of the following methods according to the construction of the camera.

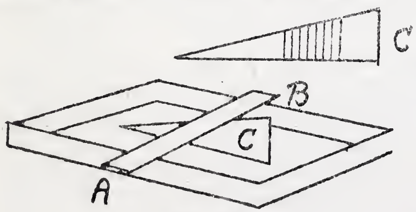


Fig. 74.

If the camera has a detachable reversing back we remove this from the camera and lay across it a flat ruler, AB (fig. 74). Then with a wedge-shaped piece of card we take the exact distance between

the rough surface of the ground glass and the under side of the flat ruler.

The ground glass is now folded back, and a plate-holder with an old negative in position is put in the grooves of the reversing back, the shutter slide drawn out, and the distance between the film of the negative and under side of the ruler again measured. If the dark slide registers truly, the two measured distances will be exactly the same. A number of parallel lines ruled on the card wedge (and numbered), as shown in the figure, enable us to compare the two measurements at sight. Should the camera be not provided with a focussing screen, we must remove the lens to some camera which is so provided. The image is carefully focussed, the glasses removed, and the T-shaped apparatus (fig. 75) inserted through the lens with its long and pointed part, E, passing through the lens tube and the cross arms, D, resting on the edges of the lens tube. D is a short flat bar of wood; E is a rounded piece of wood with one end pointed; F is a screw passing through D and into E. By turning the screw the point of E can be made just to touch the surface of the ground glass. We now return the lens tube (without its glasses) to the first camera, and again insert the measuring rod. If the plate or film is in register, the pointed end of E should again just touch the sensitive film in the roll-holder or sheath.

Fig. 75.

Infinity v. Distance.—In many of our experiments with lenses it is desirable to focus on an object at infinity. But the sun, stars, etc., though very distant, are not at infinity, yet for all practical purposes we may regard them as if they were there. But the sun, stars, etc., are not always convenient. Therefore we have to employ some distant terrestrial object, and the question arises what error is conduced by using a distant terrestrial object instead of "infinity." Suppose we are measuring the focal

length or finding the position of the focus point, and our distant object is n times the focal length from us. Then the error is $\frac{1}{n-1}$ times the focal length. For example, if the distant object be 100 times the focal length from the lens the error is $\frac{1}{99}$th focal length; if 1000 times f away the error is $\frac{1}{999}f$. Thus with a lens of 6 inch focus and object 170 yards away the error would be about $\frac{1}{1000}$ inch.

Using a Lens to the best advantage.—

(1) It is of first importance to see that the glasses of the lens are clean, free from dust, dew, etc.

(2) Direct sunlight or light from a powerful source of light, *e.g.*, lamp, etc., should not be allowed to fall on the surface of the glass or inside the hood of the lens.

(3) The inside parts of the lens mount, *i.e.*, tube stops, etc., should be dead black, not shiny or they may give rise to reflections which seriously impair the working of the lens.

(4) The inside of the camera (bellows, etc.) should be dead black so as not to reflect light.

(5) Where a lens transmits a cone of light larger than that needed to form the image, this superfluous light should be trapped by a black velvet-covered card inside the bellows. (*Vide* figs. on page 16 of "The Practical Photographer's Dictionary.")

Hints on the Selection of a Lens.

WHAT is the best lens to buy is one of those questions which cannot be answered in a sentence. Indeed, it is best answered by the querist himself by setting down on paper the *precise* nature of his needs, and then taking the advice of a lens maker of first-class reputation, and at the same time stating the limit of price he is prepared to pay. The following notes are designed to guide his thoughts to his wants rather than to offer advice in the choice of any one instrument.

Rapidity.—If the nature of the work demands brief exposures (moving objects, animals, field sports, waves, etc.,) a lens with a large or high angular aperture is essential, *e.g.*, *f*/6 or *f*/8. But this will restrict the choice of subjects to those which are more or less at the one and the same distance from the lens. In other words the larger the angular aperture the less the depth of focal field. Large aperture calls for delicate corrections and high-class optical craftsmanship with corresponding advance in price. Therefore, if the exposures need not be brief, *e.g.*, still life, copying, architecture, etc., it is not a wise investment to pay for large aperture when it is not going to be used.

Depth of Focal Field.—This is often a desideratum in landscape, architectural interiors, etc., and is more compatible with lenses of short than long focal length.

Focal Length.—For contact print work it is desirable to use a focal length which is not appreciably less than the distance at which the print is likely to be held from the eye. For whole-plates and smaller sizes this with normal vision is usually about 10 inches as a minimum. For larger contact prints the focal length should be lengthened proportionally.

Angle of Light.—This should be sufficient to cover the plate to the corners evenly when the lens is raised to the limit likely to be employed. A cone larger than this is a disadvantage, as it is illuminating the inside of the camera bellows, and unless trapped in the way referred to on another page, is very likely to be scattered, and fog the plate.

Portraiture.—For children a quick acting lens is obviously desirable. But for "grown-ups" brief exposures are best avoided. As a rule our subject is more or less at the same distance from the lens, so that great depth of focal field is not required. For large heads a lens of long focus (*i.e.*, double the long side of the plate) should be used or perspective distortion will arise. See *Single Achromatic Lens*, p. 46.

Groups call for a lens with a moderately wide angle. As the danger of movement is increased with each additional member in the group, a fairly

rapid aperture is desirable. No great depth of focal field is likely to be wanted. In portraits and groups the defect of single lenses, known as distortion or aberration of thickness, is of no practical detriment. Single lenses of modern make, having an aperture of *f*/11, can be used in a well-lighted studio or out-doors for groups and portraits, and yield a slight degree of softness of definition with very pleasing results.

A flat field lens is by no means necessary for group or portrait work. Indeed, many workers for group work prefer a lens having a little curvature of field.

Architecture. — Here we require an instrument free from distortion, *i.e.*, a rectilinear lens. Depth of focal field is often essential. A flat field may or may not be wanted. For interiors, a little curvature of field is sometimes a positive advantage. As the lens is often raised, care should be taken to have a cone of light large enough to cover the plate under these circumstances. Rapidity is helpful, but is not compatible with great depth of focal field.

Landscape.—Evenness of illumination, depth of focal field, and a moderately long focus relative to the size of the plate, are among the desiderata. Distortion, such as accompanies a modern, single high-class lens may be ignored. With most subjects and rapid modern plates great rapidity or large aperture is seldom required or used. For landscape work generally, the modern single lens deserves far more consideration than it obtains.

Copying.—Here our object is practically always a flat surface, therefore, a lens with a flat field is essential. But for process work, when it becomes necessary to stop down to, say *f*/16 or *f*/22, on account of the ruled screen used to give the dots, it is not essential that the lens should have a perfectly flat field at an aperture larger than, say, *f*/11. For copying maps, plans, or diagrams rectilinearity is obviously essential, therefore, the lens should not have a suspicion of distortion, and, of course, should be free from astigmatism.

Still Life, Flowers, etc.—The conditions here are the same as for portraits, except that the question of rapidity need not be taken into account.

Focal Length.—In all out-door work it is a material convenience from the pictorialist's standpoint to have a choice of at least two different focal lengths. In lenses of the symmetrical or rapid rectilinear type, either the front or back combination may be used as a single lens. And as each of the two components of the complete instrument has a focus of (roughly) twice that of the two together, we get a choice in that way. But with many of the modern doublets, the front and back combinations are not equal. So that by using the complete instrument, or either of the combinations singly, we get a choice of three focal lengths. Moreover, the proportions are very convenient. For example, two favourite lenses in frequent use by the present writer have the following focal lengths.

	Front Lens.	Back Lens.	Combination.
A.	$8\frac{3}{4}$	$10\frac{1}{2}$	$5\frac{1}{4}$
B.	$10\frac{1}{2}$	$12\frac{3}{4}$	$6\frac{1}{2}$

The beginner may be reminded that the *f* values of the stops as marked for the combination, are not the same for the several lens used singly. L. F.

How to Test a Lens.

WE may desire to test our lens with either of two entirely different objects in view. In the first place we may be the proud possessor of an instrument bearing the name of a maker of front rank reputation. In such a case we may rest assured that the instrument is all it professes to be. But, nevertheless, it is highly desirable for us to understand the exact nature of its excellent qualities, so that we may make the best possible use of them as circumstances may demand. In the second case we may have offered to us at a tempting price a lens without any maker's name, or one unknown to us and very naturally may desire to know if we are likely to get fair value for price quoted.

Fig. 18 (p. 63).

Taken with Lens of Short Focal Length.

Fig. 19 (p. 63).

Taken with Lens of Long Focal Length.

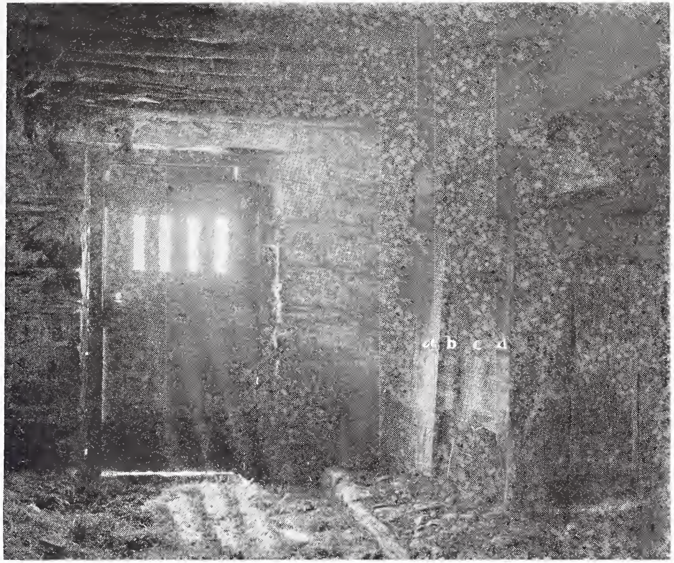


Fig. 20 (p. 64).

Ghost or Reflection Images (a, b, c, d).

Fig. 21 (p. 64).

Reversal, Flare, and Coma.

Finish.—Of course a set of poor or defective glasses may quite probably be put into a well-finished mount. On the other hand, it is not very likely that carefully executed glasses (as a good instrument necessitates) will be put into a carelessly finished mount.

Colour.—The colour of the glasses may be noted by looking through them at a piece of clean white paper. If the glasses show a greenish or yellowish tinge we may expect such a lens to work slowly.

Centring.—By this is meant that the various glasses of which the lens is made up are so put in their cells or holders that the axes of their various curved surfaces are in one straight line, *viz.*, the optic axis of the system, and that if they have any flat surfaces these are perpendicular to this axis. Mount the lens in its flange and arrange so that half a turn is yet left before the lens is up tight. Place a lighted candle in front of the lens and as near as possible to the axis of the system. Bring the eye nearly behind, but a little to one side of the candle flame, and hold a small piece of card so that the eye sees the reflected image of the candle in the lens but not the candle flame itself. A row of candle flame images will be seen in a line, their number and position depending on the number of reflecting surfaces in the lens. Now rotate the lens in its mount and note if any of the reflected images shift their positions. If the lenses are properly centred they will remain stationary in line as the lens is rotated either one way or the other.

Covering Power.—Set up the camera opposite the window of a room having a fairly open sky view. Focus for any distant object in sight. Then tilt the camera up towards the sky, and examine the corners of the ground glass to see if it is evenly lighted. If the corners are more or less dark the lens does not cover that size of plate. If it does cover when the lens is opposite the centre of the plate, then push up the sliding front, so raising the lens, and note if this gives dark corners. Should this be the case, the lens front must be marked at the point just before the corners begin to darken, so that we know how far it is safe to use the rising

front. This test must be repeated, using the various stops or diaphragms of the lens, and their effects noted.

Stop Values.—We must now measure the equivalent focal length of the lens (see page 29). Remove the glasses and measure the diameter of the diaphragm or opening in the stop by means of a wedge of card.* With a pair of dividers see how many times the diameter of each stop is contained in the equivalent focal length. Compare this with the marked value of the stop. For instance, suppose the focal length of the lens is 8 inches and the diameter of the opening is ½ an inch. This (½ inch) is contained 16 times in the focal length (8 inches) of the lens, and so this stop should be marked $f/16$.

Verify by the following and more accurate procedure. Focus a distant object and clamp or mark the position of the ground glass or camera extension. Remove the ground glass. Replace it by a sheet of card in which a hole ⅛ inch diameter has been punched in the centre. Behind the hole and close to it put a candle or lamp flame. Fit a piece of ground glass or tissue paper to the hood of the lens, and with each stop note the diameter of the circle of light produced on the tissue paper by the candle flame behind the small hole. This is the efficient diameter of the stop. This test may best be used in a fairly dark room.

Distortion, or Aberration of Thickness.—Set up the camera opposite an open door giving a fairly dark background. From the door suspend a white thread and hang a small weight, *e.g.*, a key or bullet, to the lower end. Arrange the back of the camera so that the long way of the plate is vertical and so that the white thread is seen within ¼ inch of the margin of the ground glass. Focus this white thread sharply, and then with the aid of a straight edge or ruler applied to the ground glass, see if the image of the vertical and straight thread is truly straight on the ground glass. With a single lens having the stop in front of the lens this error or defect will show itself, if present, by bringing the *middle* of the thread image nearer the margin of

* *Vide* p. 73 of *The Practical Photographer's Dictionary.*

the plate than at the top or bottom. If the stop is between the lens and the plate the middle of the thread line will be curved towards the centre of the focussing screen.

As a matter of fact, this defect is somewhat generally exaggerated, and in many of the high-class single lenses is so slight that it may be ignored for most practical purposes. But a single lens is not suitable for copying maps, plans, diagrams or architectural work where straight lines come near the edges of the plate.

Curvature of the Field.—For this and some of the following tests it is convenient to fix up flat against a vertical wall four sheets of newspaper having some bold type. The advertisement pages are often quite suitable. The wall may be in or out-doors, but should be well and evenly lighted. By measurement find the centre of the paper covered portion of the wall, which may conveniently be about six feet square. Opposite the centre set up the camera. This may be tested by tying a piece of cotton to the lens and measuring its distance to the four corners. Be careful to point the axis of the lens in a line perpendicular or normal to the surface of the wall.

With the largest stop, focus the centre of the newspaper, examine the corners of the ground glass. If the centre and corners are all equally sharp the lens has a *flat field.* This is a valuable property only found in modern high-class lenses. It is of special value for copying, and *some* phases of architectural work. With the older form of lenses it will probably be found that when the centre of the printed matter is sharp the corners of the ground glass are not sharp, but they can be got sharp by altering the distance between the ground glass and the lens. But this will throw the central part out of focus. When this is the case the field is not flat, but curved. Usually we have to approach the plate to the lens to get the margins sharp. In this case it is sometimes called positive or concave curvature, and negative curvature when the distance has to be increased.

By focussing for a point about half-way between the centre and the middle of the nearest side and

using a medium sized stop, it is often possible to get all parts of the ground glass in equally and sufficiently sharp focus.

Astigmatism.—When this defect is present it is not possible to focus with equal sharpness vertical and horizontal lines. This most affects the corners of the plate. We therefore take a sheet of note-paper and rule on it two or three thick black vertical lines about an inch apart, and as many similar lines crossing the first set at right angles or horizontally, and then fix this paper to the wall in such a position that its image comes fairly near one corner of the ground-glass. Unless the lens is stigmatic (anastigmatic, holostigmatic, etc.), it will not be possible to focus both sets of lines at the same time with equal sharpness with a large stop. But often a lens that shows astigmatism with a large stop is pactically cured by the use of a small stop. For copying and architecture a lens free from astigmatism is desirable, but in portraiture and ordinary landscape this defect, unless pronounced, is not very serious.

Spherical Aberration.—With the largest diaphragm focus as sharply as possible the centre of the printed matter and set an assistant to put in a small stop while the image is watched. If any perceptible change in sharpness results, the lens is not fully corrected for this aberration. Repeat the experiment when the corner of the ground glass has been sharply focussed with open aperture. The experiment given on page 20 may be repeated.

Flare.—Point the lens to a small bright object in front of or close to a dark object. At night a lamp in front of a dark curtain will answer. Focus sharply and be on the watch for a disc or patch of light. This "flare spot" may be a small spot, a disc of considerable size or so large that it entirely covers the plate. If the ground glass be removed the cone of light may be tracked towards the lens by means of a small piece of ground glass held in the hand. It would seem that either local or general flare is inevitable, and it is better to have it spread all over the plate and so diluted, as it were, than confined to one small spot. It largely

depends on the position of the diaphragm and curvatures of the lens surfaces, and may be caused by the bright edges of the diaphragm. (Figs. 21-2-3.)

Reflection Images may arise from some part of the lens tube or camera bellows being bright and shiny. These, of course, are not properly matters of lens testing, but in practice they call for notice and remedy by "*dead blacking*" the offending parts.

Ghost Image or False Image.—This is a secondary image formed by reflection and refraction. This is liable to arise with the doublet forms of lenses, when a light object surrounded by much darker objects is towards the centre of the picture. The ghost image often appears upside down on the ground glass. It is necessarily much more feeble than the primary image, but it can be sharply focussed, though not at the same time as the primary image. When a ghost image is formed, and the camera turned from side to side, the ghost image moves in the opposite direction to the primary image. A small, brightly lit window facing the camera in an interior picture is liable to form a ghost image. (Fig. 20).

Striæ.—These are due to irregularities in the composition or structure of the glass itself. A near lamp flame is focussed on the ground glass. The ground glass is then removed, and the eye placed to receive the image of the lamp flame. The whole lens appears as a bright disc of light, and any striæ will show as branches, feathers, stars, etc. Striæ look much more alarming than they usually are so far as the performance of the lens is concerned. A lens which has passed the tests or examination already outlined, need not be rejected for striæ.

Defects.—A scratch on the surface of a lens or an air bubble or black spot in the body of the glass of an otherwise good lens will have no effect on the formation of the image. And the small proportion of light lost by such defects as these (probably not one-five-hundredth part of the total possible) may be entirely neglected. But if the lens has had a fall it is quite possible that a strain far

more serious has been caused, although to the ordinary observer no effect has been produced.

Chromatic Aberration.—This can best be tested by exposing a plate in the camera upon a suitable test object. Take a strip of white card 2 feet long and, say, 3 inches wide. Draw a straight line down the centre, lengthways, and divide this by 22 vertical lines, each 2 inches long and an inch apart. Put O at the centre and number the lines in order 1 2 3 from the centre on one side and use letters A B C, etc., on the other side of the centre (fig. 76.)

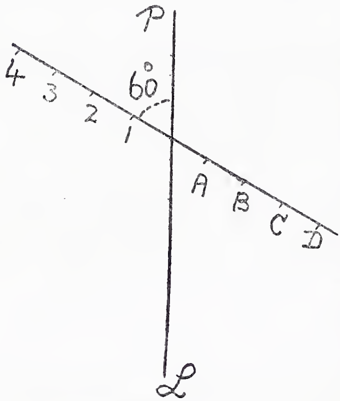


Fig. 76.

Set the card up horizontally, with its centre, O, opposite the lens—but give it a side twist so as to make the card be at exactly 60 degrees with the axis of the lens. Now focus the central line sharply with the largest diaphragm. Expose and develope a plate. If the visual and chemical rays are properly corrected so as to have the same focus, then our negative will show the central line, O, as the sharpest. But if any other line nearer or farther away than O is sharpest on the negative, then obviously the photographic image does not agree with the visible image. The lens is not corrected from chromatic aberration. As our marks are one inch apart and the scale is tilted at 60 degrees, then it follows that the marks are practically each half an inch further away from the lens than the next mark. By observing which mark comes sharpest on the negative we can make a corresponding allowance when using such a lens if needed.

Another method is to cut a narrow slit with an old knife in a sheet of tin or ferrotype plate, and to cover it with a piece of deep blue glass. Arrange bright daylight behind this and then focus the image

Fig. 22 (p. 64.) Flare and Zonal Abberation.

Fig. 23 (p. 64.) Flare.

of the blue slit as sharply as possible. Then remove the blue glass and substitute for it ruby glass, and see if the image is still as sharp as before. But as both the blue and red glasses in all probability pass rays other than blue and red, and as the most chemically active rays are barely visible to the eye, this method is inferior to the methed of using a plate and making it tell its own tale. W.H.R.

Angle of Emergent Cone.—It is very useful to know the size of the cone of light which the lens throws into the camera. *1st. method.* Attach the lens to a camera of size considerably larger than the plate is known to cover. For example, suppose the lens covers a $\frac{1}{4}$ or 5×4 plate. Fix it into a $\frac{1}{1}$-plate camera. Focus for "distance," remove the ground glass and replace it by a sheet of clear glass. In a piece of card punch two small holes $\frac{1}{8}$ inch diameter, and an inch apart. Point the lens and camera up to the sky, cover the head with the focussing cloth, lay the card on the ground glass, and move it about until one hole is somewhat dark, while the other is quite bright. In this way the edge of the cone of transmitted light may be located on the clear glass, and its base measured and compared with distance between the clear glass and posterior node of the lens where the cone angle is easily determined.

2nd method. Focus for distance and point the camera to the sky. On a piece of finely ground glass somewhat smaller than the focussing screen (say $\frac{1}{4}$-plate for $\frac{1}{2}$-plate camera), draw a circle with pencil and compass having a diameter in definite number of half-inches, say 3 inches on a $4\frac{1}{4} \times 3\frac{1}{4}$ piece of glass. Remove the focussing screen of the camera, and holding the smaller piece of ground glass in the hand, move it towards the lens until the cone of intercepted light just fills the pencil-drawn circle. Now note the precise distance between the ground glass and lens. With these data the cone angle can easily be determined.

The Lens Hood.—In some forms of lenses designed to transmit a wide-angled cone of light it will be found that the lens hood interferes with the satisfactory working of the lens when a large stop is in use. Adjust the lens for an object at its normal

working distance, and then point the lens and camera towards the sky. Now remove the ground glass and place the eye at the lower corner of the camera opening (*i.e.*, corresponding to the lower corner of the focussing screen), and look through the lens at the sky, when it will easily be seen if the lens hood cuts off a portion of the light which otherwise would come through the stop. If this be the case a note should be made as to which is the largest stop that can be used without any light being cut off by the lens hood, and no stop larger than this should be used if even illumination is desired. R. D.

Polish.—The efficacy of a lens largely depends upon the degree of polish of the surface of the glass. When the polish is of first quality the surface has a dark, but yet lustrous, surface. But when it is imperfect the surface has a slightly grey, or dusty appearance.

The Care of Lenses.—A modern high-class lens is an instrument upon which great care has been expended in its making, and as its cost is usually something worth thinking about, it certainly does seem surprising that photographers in general do not pay a little attention to its care and preservation in fine working order.

When not in use in the camera, it should be kept in a small wooden box or stout wash-leather bag. The cap should be placed on one end, and, whenever possible, a second cap should be made to fit the other end. If the ends cannot be capped, the whole lens should be wrapped up in a piece of old, well-washed, soft silk.

A lens should be kept in a pure, dry, and not too hot or cold atmosphere. An uncovered lens should not be left in strong daylight, or in an atmosphere where gas is burnt. A lens that has been left for some time in a cold place when taken into a warm or damp atmosphere will act as a condensing surface, and become covered with a layer of very fine dew drops. This layer may scarcely be visible to ordinary observation, but will prevent it forming a proper image. Therefore, in the winter end of the year, the lens should be kept in a living room heated by a fire. Great heat, either by sun or fire,

should be carefully avoided, or the cementing of the glasses will be disturbed, necessitating the cost of returning the lens to the manufacturer.

Cleaning Lenses.—This should be done with the greatest care. The fine polish of some of the softer forms of glass now used is easily degraded. Do not touch the lens or mount with dirty fingers. Having removed the lens from the lens tube, hold it by the metal rim and lightly dust the glass with a quite clean soft camel-hair brush. This brush should be kept for this purpose only. If the lens has previously been properly cared for and kept wrapped up nothing more will be required. But its surface may have been spotted by rain-drops, etc. In that case apply a drop of distilled water or pure alcohol (*not* methylated spirit) and rub very *gently* with a small piece of very soft silk or a fragment of an old, but clean, cambric handkerchief.

The Lens Tube and Iris Diaphragm.—These being coated with a dead black paint will in the course of time shed a few fine particles which may find their way to the surface of the glass. Whenever the lens is opened for cleaning all the inside parts of the tube should be gently brushed out with a small *soft* hog-hair brush to remove any loose particles, but care must be taken not to rub any of the inside parts so as to make them smooth or bright.

Putting the Lens together.—It is of first importance when replacing the lenses into their tube mount, that they should go into their proper places and also that the "threads" should engage properly. The best way to secure this is to place the lens in the open tube and turn the lens round as though it were being *un*screwed. Presently a tiny wee "click" will be heard, which tells us that the ends of the thread are just opposite, and now is the time to screw up the lens.

Some Experimental Results.—In figs. 18 and 19 we have two views of the same room interior taken under precisely similar conditions from the same standpoint, *i.e.*, the camera occupied the same position in both instances. In fig. 18 the lens used was of very short focal length as compared with the size of the plate, *viz.*, a focal length of about 5½ inches

with an $8\frac{1}{2} \times 6\frac{1}{2}$ plate. In fig. 19 the lens used had a focal length of about 12 inches, and as before the plate was $8\frac{1}{2} \times 6\frac{1}{2}$ inches. The thin white line in fig. 18 shows the limit of view of fig 19. So that if the portion within this white line were enlarged the result would be very similar to, but *not absolutely* identical with that in fig. 19. Although the plate occupied the same position for both exposures the lens was nearer the plate in fig. 18 than in fig. 19, and consequently the perspective in the two cases is not quite the samc.

Fig. 20. This shows the interior of a small stable. In the door are four narrow slits. Strong light streams through these and gives four corresponding patches of strong light on the hay-strewn floor. But to our right may be seen false or ghost images of these slits formed by reflection from the surface of the glass of the image (a, b, c, d).

Fig. 21. The camera was pointed up to the sun, which was in sight just above the roof of a tall house. Note that the sun's disc owing to *reversal* prints dark. In the centre is a large sharp-edged flare spot, and below this a soft-edged smaller patch or coma, the result of oblique pherical aberration. In this case a single landscape lens was used.

Figs. 21 and 22 are both examples of flare arising from the use of doublets with several reflecting surfaces.

In fig. 21 the various flare circles are more or less concentric and the edges somewhat brighter than the other parts, the result of a worn Waterhouse diaphragm.

In fig. 22 the lens is of a quite modern type fitted with an iris diaphragm.

Note carefully the several different flare circles, and how the peculiar configuration of the iris diaphragm opening is recorded.

Final Note.—The readers will ere this probably have noticed that we have passed over many subjects, *e.g.*, pinhole photography, tele-photography, micro-photography, stereoscopic work, lantern projection, etc., and will have rightly conjectured that it is our intention to say something on these topics in those of our future numbers which will be more especially concerned with these topics.

Some Timely Lists.—From **Messrs. Houghtons'** come no less than four entirely seasonable booklets, or descriptive and illustrated price lists. First, we have a long array of Christmas Greeting Cards in almost countless variety. This is printed on art paper and illustrated by some exceptionally well-executed reproductions. Indeed, the country customer will be at no disadvantage, as he can easily arrange his orders with this list before him.

Next, we have a very complete catalogue of *Enlarging Lanterns and Accessories* in great variety. The lantern outfits range from £2 17s. 6d. upwards.

The companion booklet deals with *Optical Lanterns, Slides, Carriers, Jets, etc.*, and all sorts of things one could possibly want for making slides and displaying them.

Finally, an interesting list of Toy Lanterns, Model Engines, Binoculars, Models, and a thousand and one things suitable for Christmas presents.

Messrs. Houghton have kindly stated that they will forward any of these lists free of charge to any of our readers who will send their address to 88, High Holborn, and mention *The Practical Photographer*. And we can strongly recommend anyone contemplating the purchase of any article at all likely to be found in any of these well-arranged and comprehensive lists, to secure and examine these lists, in which they are more than likely to find the article required at an attractive price.

Xmas Greeting Mounts. From **Messrs. Fallowfield** comes a sample package of mounts and folders designed for Yule-tide greetings to absent friends. It has given us great and sincere pleasure to examine these mounts one by one, in spite of their almost bewildering variety, for it shows what an enormous advance in refinement of taste has come over the Xmas-card-sending photographer in the last year or two, and we offer Messrs. Fallowfield our congratulations and thanks for their important contribution in this direction. Among the many charming designs we would like to make special mention of Costa, Felicia, Mentone, No. 249, 276, 246, 239, 256, 214.

From **Messrs. Houghton,** who are ever on the alert to anticipate our wants and supply them almost before we have realised them, we have received a **Trial Outfit of Ensignol.** This is in a metal-capped bottle, containing a ¼-oz. tube of Ensignol and 2½ ozs. of soda sulphite. All we need do, therefore, is to dissolve the sulphite in a pint and a half of water, add the Ensignol, and we have at once a vigorous and economical developer which yields bright, clean and stainless negatives; or if bromide or gaslight papers are engaging our attention at the moment, all we need do is to dilute the solution with at least an equal quantity of water. This outfit costs only 8d., or, say one farthing per oz. of mixed developer. The **Ensign Developing Canister,** from the same firm, is a similar arrangement, but this time, in place of the glass bottle, a canister is used. This contains a small tube, whose contents should be dissolved in a pint of water and labelled No. 1. The other contents of the canister are in another pint of water and labelled No. 2. By taking equal parts of No. 1 and No. 2 and mixing we have our well-tried and trusty friend, pyro-soda developer. In this way, for a modest shilling, we have 40 ozs. of developer. The convenience of this canister arrangement for the traveller is too obvious to need more than mention.

From **Messrs. Butcher & Sons** comes a handy little "pocketable" list of lanterns in astonishing variety and sizes, at all sorts of prices. The lecturer's lantern, the bi-unial, the cinematograph and the toy lantern are all here, as well as jets, cylinders, stands, etc.

The same firm also issue a gratis pamphlet entitled, "How can I enlarge,' wherein the matter is set forth in the simplest manner and language. Suitably placed at the end of this pamphlet we find a great variety of enlarging lanterns described and priced.

The next item is the well-known and widely esteemed Lanternist's Pocket Book, containing a fund of useful information about electric supply, cylinders, lanternist's reference tables, and a compact diary. Finally, a freely illustrated list of winter novelties, toys, working models, etc., which should prove very welcome Xmas presents to young people generally.

An Interesting and Instructive Pamphlet, is No. 78 of the "Electricians' Booklet Series" (Published 1, 2 and 3, Salisbury Court, E.C). It deals with Photo-engraving in a simple and concise manner and includes some excellent illustrations. If the other numbers of this series (whichcost but threepence each and deal with a great variety of electric topics) are as good as this one, we may confidently recommend them unseen.

Some Xmas Greeting Cards.—From Messrs. Kodak comes a collection of dainty and attractive cards for the approaching Xmas-tide. These are listed as the "Chic" series, and perhaps that is the best word to describe their general character. At any rate, call them what we will, they are all exceedingly dainty and tasteful and in a word they are just the very thing to make the very best of a photographic print. They are in great variety, such as Folding slip-in, Folding paste-on, Hand-made with deckle edges, Marbled Art, Calendars, Red Seal series, etc. They are made to take every imaginable shape and size of print and range from ninepence per dozen upwards. And it is particularly welcome news to learn that these desirable and tasteful mounts are British-made goods.

Harmsworth Self-Educator, No. 1, price sevenpence, is before us, and we are very favourably impressed with the concise and sound information it contains upon an almost bewildering variety of topics. One cannot open the book at any place without finding something well worth learning. We hope to see other numbers of what promises to be an epoch-marking series.

The Bromide Monthly and Photo Notes (Rotary Photographic Co.) The October number of this neat little serial contains among other items of interest an admirable chapter on the making of negatives for photography in natural colours.

Exhibition.—Société de Photographie de Marseille. The prospectus of the Fourth "Salon International d'Art Photographique" is to hand. Applications should reach the "*Secrétaire Général de la Société de Photographie de Marseille, Rue de la Grande Armée,*" before the 31st of December, 1905.

Messrs. Butcher & Sons have sent us a sample slide of their Junior Lecturer's Lantern Slide Series of Natural History Subjects. Each set contains eight slides.

Ensign Developing Canisters, containing enough material for 40 ozs. of developer can be had in four varieties, *viz.*, Imperial Standard, Imperial Pyro-Soda, Imperial Hydroquinone and Imperial Metol-Hydroquinone. These formulæ are now so widely (and justly) popular that we need do no more than mention the convenience of these canisters in connection with them. In all four cases the price of the canister is 1/-.

Messrs. Kodak have sent us a leaflet describing an instrument called the Foldscope. This is a hand-stereoscope with an attachment for holding the picture on an extension platform arranged on the "lazy-tongs" principle so that the apparatus when not in use can be folded up into a very small compass. The Foldscope is made in three patterns at varying prices from 3/9 upwards. The demand for an instrument of this character is renewed evidence of the active revival of stereoscopic photography. The Foldscope meets this demand in a practical and economical manner.

"**Sir Benjamin Stone's Pictures**" is the title of a sevenpenny monthly just started by Cassell & Co. It contains a goodly number of reproductions of his photographs about whole-plate size. Each picture is accompanied by a brief but ample note giving the salient features of the incident or place depicted. We welcome this publication with open arms and only regret that it did not make its *début* half a century ago so as to have stimulated others to go and do likewise and so preserve reliable records of quaint customs and interesting buildings, which in these days of change are being educated, or restored, out of existence. The work is of *national* importance and we trust it will be widely supported, not only as a pleasure, but also as a duty to posterity.

A Remarkable Catalogue.—"Fallowfield's Photographic Annual for 1906," with its 1220 pages of closely-packed information and 2122 illustrations, is a truly surprising record of the almost incredible variety of photographic apparatus and materials that can be obtained through this enterprising firm. Year by year this mammoth list seems to go on growing and retains its freely accorded character of being one of the indispensable reference books of photography. For the benefit of those who have hitherto neglected to make its acquaintance we may explain that this is *not* a miscellaneous collection of various dealers' and manufacturers' lists and catalogues bulked up together, but it is *one book systematically arranged and well indexed.*

Some New Guide Books.—(1) Woking and Ripley, (2) Hertford, (3) Huntingdon, St. Neots, St. Ives and the Great Ouse, (4) Lynton, Lynmouth and the Lorna Doone Country. Here are four more of the quite excellent series of Homeland Handbooks, to which we have referred with much pleasure on

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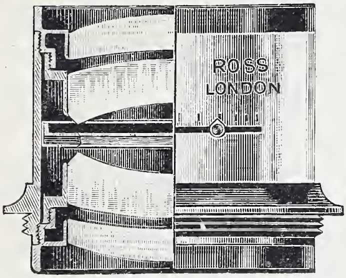

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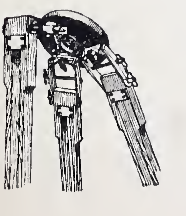

Dear Mr. Butler, Caterham Valley, Surrey, August 4th, 1905.

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I remain, Yours ever faithfully,

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WRITE FOR PAMPHLET, PRESS COMMENTS AND TESTIMONIALS.

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former occasions. The first three on our list are published (Homeland Association, Bride Lane) at 1s. each, the last-named at 6d., and remarkable good value they all are. The general editor of the series well deserves the thanks of photographers for thus enabling them to learn something more about our own country and its many wayside little known beauties and interests. It is one of the greatest and commonest faults to think that we want to go off to some foreign country to find places of photographic interest. If the editor could see his way in the future numbers to include maps on a scale of two miles instead of one mile to the inch, the change would be greatly appreciated by the pedestrian.

"**Circoids!**"—What are circoids? These are circular or disc-like tablets which when dissolved in water give us various photographic solutions ready for use, thus obviating the necessity for weighing small quantities of materials. **Messrs. Houghton** have put these on the market in neat little boxes, which are just the thing to slip into a vacant corner of one's portmanteau and enable a trial plate to be developed when away from home. For example, the metol-quinol box, containing enough circoids to make 40 ozs. of developer, is not so large as the familiar Byrant & May's match-box. In two ounces of water we dissolve one A and one B circoid, and we have just what is wanted for a trial quarter-plate. For one shilling we can have either 40 ozs. of pyro-soda developer, 40 ozs. of metol-quinol developer, or 20 ozs. of gold toning and fixing solution. We need hardly add that this is remarkably liberal value for the money. The paper of instructions wisely adds the necessary Watkin's development factor in each case. The fact that these preparations are issued by Houghtons is sufficient guarantee in itself that the materials themselves are of a thoroughly reliable quality. For the tourist, cyclist, traveller and occasional worker, circoids will be found not only convenient but economical, as there need be no waste, no stale developers, or cumbersome accumulation of bottles.

Mr. Wm. Tylar sends us a sample box of "Unique" folding Xmas motto mounts, containing a dozen cards with suitable envelopes. The cards are all of neat and effective character, and for the most part are of a decidedly light if not white colour. We have no doubt that these cards will be as popular as previous issues from this firm. Mr. Tylar also sends us a leaflet describing various other attractive little things such as he is famed for providing.

More Xmas Cards reach us from **Messrs. Houghton** just at the moment of going to press. These last arrivals are by no means the least in point of merit. Indeed, they are conspicuous for their originality of design and tastefulness in colour schemes. Along with these comes a booklet price list arranged on eminently attractive and sensible lines. Each page is devoted to a thorough description of one card only, and further embellished by an excellent half-tone block made from a photographic original. Messrs. Houghton will send a copy of this booklet to any of our readers who will apply to them at 88, High Holborn. With this admirable price list before them our country readers will be able to make their selections and arrange their orders with complete confidence and without a moment's fear that they will be disappointed in the goods chosen.

Photograms of the Year 1905. (Dawbarn & Ward).—This is one of the yearly volumes that has made for itself a warm place in our affections, and we are glad to say that the present volume is a worthy companion to its ten elder brothers. The current pictorial photography of France, Germany, Denmark, Canada and Spain are dealt with by R. Demachy, F. Loescher, J. C. Stockholm, H. Mortimer-Lamb and M. Mendez Leon respectively, and A. C. R. Carter, as usual, contributes many helpful notes on the work of the Salon and Royal. The book runs to 160 pages and includes about 150 pictures by many of our best known workers, so that it is remarkably good value for the price, *viz.*, 2s. We incline to the impression that this year's volume is a general advance on its several worthy predecessors, and no ambitious pictorialist can afford to do without it.

Prints for Criticism, etc.

Will competitors and others please kindly note our rule to the effect that when prints are to be returned stamp must be sent **WITH THE PRINTS**—*not afterwards?*

Will contributors to our various competitions kindly refrain from sending under one cover prints for different competitions? This not only gives us

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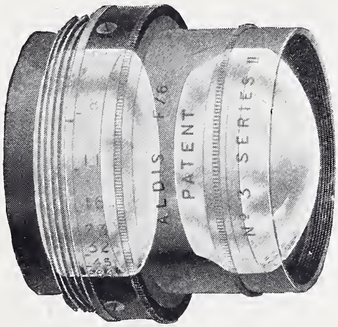

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considerable trouble, but involves the risk of the various pictures not being properly entered for the competition for which they are intended. It is far better for all concerned to send each lot of prints in separate parcels.

Playtime (W. H. Nithsdale).—Jan.; 11 a.m.; sunlight; Ilford Monarch Plate; *f*/11; exposure, 1-30th sec. It would not be difficult to discover half a dozen things to find fault with in this picture, but in spite of them all there comes forward a more than compensating suggestion of a bright sparkling morning, the ringing laughter of the playing children, the crackle of their pattering feet on the crisp snow, the contrast of the grim and unlovely school building and the joyous freedom of unconventionalism in the young lives of the scholars. All we ask is that the sky part shall have given to it a better suggestion of atmosphere and less of blank paper, and that the long snaky wall on our right shall be subdued in its distant parts. Fig. 10 *(Bronze Plaque, Figures Competition).*

Reflections (E. S. Maples).—Single lens; *f*/16; Feb.; 3 p.m.; Iso plate, backed; exposure, 1 sec. Printed on Luna fabric. Reflections in all the varied and alluring colours of nature are one thing, but in the monochrome of the photographic or ink print this case seems entirely different. However, in the print before us this author has wisely chosen a rough-grained printing surface, which softens and subdues the many needless details, and the effect is a very agreeable departure from the beaten track. We should like this still more if the trimming knife had removed about ⅝ inch from the lower edge. Fig. 11 *(Print Criticism Award).*

Landing Mackerel (C. B. Alexander).—May; 7 a.m.; bright light; rapid plate; *f*/8; exposure, 1-30 sec. This picture shows us some of the ways wherein the painter has his advantages and disadvantages when compared with the camera man. The latter scores by his power of catching characteristic pose or suggestion of action. The painter possesses without limit, let, or hindrance the power of leaving out, and in the case before us doubtless he could have omitted about half of the various boats which we see dotted about in the distance. The suggested movement of the man in the water should be carefully studied. Fig. 12 *(Print Criticism Award).*

Winter (J. Walton).—To every rule an exception, and the print before us exemplifies the exception to the general rule as to the desirability of a suggestion of cloud. But in the winter season when every blade of grass is fringed with ice crystals, it often happens that with a clouded sky we have a slightly foggy frost-laden atmosphere that is particularly noticable towards the horizon. The print before us shows this admirably. We are not unlikely to have weather of this kind during the next few months, and the observer of nature should be on the look out for effects of this character. This print well exemplifies the quiet and agreeable tone of a simple subject treated in a simple and straightforward manner, without straining after theatrical effects. Fig. 13 *(Champion Competition Certificate).*

Hushed and Still (H. B. Cookson).—Sep; 5 p.m.; Iso plate and screen; *f*/16; exposure 20 seconds. The difference between the better work of to-day and the best work of say ten years ago is shown in the matter of sky treatment and choice of titles as much as in any other respect. In this very pleasing picture we have an apt instance of how much the general effect is dependant on the sky part, and how an aptly fitted title seems to strike just the right keynote to our thoughts. The choice of the colour of the mount does not quite suit that of the prints, and perhaps the general effect is enhanced by the fact that our reproduction does not give any suggestion of the colour of the omitted mount. Fig. 14 *(Print Criticism Award).*

The Knitting Lesson (D. W. Elliott).—Sept.; 11.30 a.m.; *f*/8; exposure, 10 secs. A picture to be commended for its unaffected simplicity. The balance of light and shade about the "teacher" is admirable, but not so satisfactory as regards the pupil. The tie or ribbon beneath the child's chin is just a little fidgeting and "liney." The reader will probably see for himself that had this ribbon tie been removed the picture would have been more forceful and convincing. The sharp straight edge of the lace curtain against the dark background might have been broken by a fold or crease with advantage. Fig. 15 *(Certificate, Figures Competition).*

Winter Sunlight (J. Dunlop).—Particulars not given. This is an entirely creditable and pleasing little work characterised by unaffected simplicity and neatness in general execution. We hardly dare hope to retain in our reproduction all the transparent delicacy of the cast shadows on the snow that are rendered in the original. It is just a little unfortunate that the bent branch

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towards the left margin is so very like a croquet hoop somewhat out of correct shape. Fig. 16 *(W1nter Competition, Certificate).*

"I am the Way, the Truth, and the Life" (B. Jackson).—Bright afternoon; iso. plate; *f*/16; exposure, 20 minutes. A well-balanced composition carefully executed and appropriately mounted. The distribution of light and shade is not quite as quiet and broad as one could wish, and the bench end in the right-hand lower corner is a little too insistent on our attention. If the worker could subdue the strong light on the bit of floor seen through the arch, the two notices on the board beyond and also slightly soften down the light coming through the topmost window, the general effect would be emphatically strengthened by a degree of quietness that the print before us just misses. Fig. 17 *(Champion Competition, Certificate).*

J. W. P. (Tamworth).—All three prints are decidedly creditable, and you may be glad to know that you were one of those whose prints remained on the table right up to the very last moment of judging. (1) Here it was a mistake to include the figure on our left near the margin. The various lines of shop-awning framework come uncomfortably. Generally the shadows are a little too heavy. The original negative probably slightly under-exposed, and possibly also slightly pyro-stained. This slight stain makes an enormous difference in enlarging with artificial light. (2) The proportions here are very much better. You have rather too much foreground, and might well cut away about three-quarters of an inch. The sky part is too much of one tone, *i.e.*, monotonous in the strict sense of the word. (3) All things considered, this is the best. The chief fault here is the uncomfortable, strongly-contrasted line of buildings against the sky on our right. At first this looks more like a defect in the plate than what it really is. Here, again, the sky is too monotonous and generally this and No. 2 are a little degraded in the highest lights; this is probably due to developer stain.

Mrs. B. (Wisbech).—(1) This is by far the best of your three prints, both as regards pictorial and technical qualities. We can best help by pointing out the chief faults for your future guidance. The sitter has the unfortunate conscious expression of being photographed. This is one thing to be avoided at all costs. He is holding the paper too firmly, as if he thought it would be snatched from his hands. The small patch of white at the top of the pocket should have been removed, and the two or three glinting lights on the chair are distressful and should be softened down by a little careful work on the print. We also suggest the use of a somewhat rough printing paper. (2) This, though a favourite pose, always seems to us slightly artificial. The light and contrast of the face are a little too strong; you need the use of a reflector. On this topic carefully read through what is said in our recent No. 20, which will help you in many directions if carefully studied. In portraiture keep your negatives soft and delicate in contrast. (3) As a rule a large mass of white or light draperies is to be avoided with either dark complexions or dark hair, as the contrast effect is often overpowering and tends to exaggerate the darkness of the hair and complexion. We should say that this negative has been under-exposed and over-developed, hence the lack of gradation in the high-lights; also the light is too general, that is to say not sufficiently limited in direction, hence the absence of those all-important shadows.

F. D. (Weston-super-Mare).—(8) This is nearly a very successful picture, but just missed it for want of a little technical craftsmanship. The pose of the head and lighting of the figure are quite excellent, but the placing of the chair in this manner without some obvious reason does not seem satisfactory. Near the chair you might have had the edge of an old-fashioned table or bureau. The figure is just a little too large for the print, that is to say you have overdone the trimming. (9) This figure is well posed as regards the decorative arrangement of the picture space, but the expression is very severe and forbidding; the hand stiffly posed and the stripy nature of the dress not at all suitable for pictorial effect. It was also a mistake to surround your print with a light border. (10) Colour of the print too cold to be agreeable or harmonious with the suggestion of sunlight. The mounting of this print is in very good taste. Try a similar print and dip it in a bath of strong tea, or preferably coffee, so as to slightly tint the paper itself, or you might advantageously warm the colour by a slight toning in the uranium bath.

E. M. C. (Norwich).—(1) It is always extremely difficult to convey any adequate idea of the size of mountains without the introduction of some mental measuring rod such as a cottage or a group of cattle or something of that kind in the near foreground. Your print seems to fall off from one side to the

other as though the negative had been fogged. For this we can offer no suggestion by way of remedy. On the subject of mountain photography of this kind you could not possibly do better than to study carefully the first few pages in our No. 10, whence you may glean exceedingly valuable hints from one who is an acknowledged master in this work. (2) This is an extremely interesting and curious object and gives one a very fair idea of its general nature. We assume that your print is an enlargement, the high-lights are evidently rather dense and therefore we would suggest that you should try again, giving a more generous exposure and diluting the developer with about twice its bulk of water; it is probable that your original negative is somewhat pyro-stained and this would account for the hard contrast in the enlargement. For the reduction of pyro stains and kindred matters consult our No. 7 on after-treatment.

H. C. (Campbell Town).—This is a very charming bit of natural scenery and one which requires the element of size in the picture to give us any adequate impression of its grandeur and beauty. We therefore first suggest that this should be enlarged to not less than 16 by 10. Use the roughest surface paper you can purchase. Aim to bring out the clouds a little more distinctly; soften the sky line of the distant hills and try to keep the foliage, trees, etc., towards the middle of the picture from getting too dark and strongly marked against the water background.

C. D. B. (Lancaster).—(1) An interesting result from the experimental point of view; pictorially it is quite a mistake to cut up your picture by a dark band of mountains or anything else right across your picture from side to side. At first glance the picture looks almost like two prints put one on the top of the other. The exposure has not been sufficient, hence the dark over-solid looking distance, which does not, however, look as distant as it should. (2) This is far better from the pictorial point of view. Here your sky is just a little too strongly pronounced. This seems to bring it too near, and this attracts the attention away from the landscape itself. We should prefer this print on decidedly rough surface paper, so as to subdue the many small details in the foliage. (3) The little portion of this print showing the slightly hazy distance is quite excellent indeed. We should suggest your removing $1\frac{1}{2}$ inches from the top of your picture and $1\frac{3}{4}$ inches from the right-hand side. This would leave you a really charming fragment, which is much better than the whole print at present. The many small strongly-marked details of leaves and twigs are very distressing and unrestful as you may see by comparing the upper portion with that in the middle distance.

T. C. (Grange-over-Sands).—(1) This print is really a very pleasing composition and arrangement of light and shade, but it seems to want just a little more definiteness in the sky portion, which at present is an indefinite patch. You might with advantage, therefore, slightly darken the right-hand lower corner for a space of $\frac{1}{2}$ an inch or so. (2) The figure here is too near the centre of the picture to give really decorative composition. You might well spare about half an inch from the right-hand side and, say, $\frac{1}{4}$ from the lower side; this would give a much better balance of shape. The colour of this print is not so pleasing as that of No. 1. (3) In this case it seems to us that the colour is a little too warm, that is, too red. The margin of the picture generally might with great advantage be slightly darkened all the way round the lower two-thirds of the print, and if you could at the same time slightly subdue the strong light on the water this would also be a very great advantage.

A. C. (Leeds).—(1) You have here ample material for a strong and striking picture, but you have not used your opportunities to quite the best advantage; however, try again; bring the figure a little nearer the centre of the picture, but not, of course, in the centre; then move your camera a little to the left, be careful so to arrange matters that the outlines of any part of the figure do not run into the line of the rough edge, also be careful to see that the objects behind and beyond the figure do not make awkward patches or sharp lines. Next put your figure in sharp focus and let the rest be slightly softened. Cut away $\frac{1}{2}$ an inch or rather more from the lower edge and add as much at the top. (2) This is not up to your best form; we suspect that the negative has been under-exposed and over-developed, hence the high-lights come to be solidly white and the detailed shades and the darks are all but lacking. The contrasts of light and shade are unpleasantly strong. (3) This is much quieter and better. Here you should try to subdue the tree portion in the distance, which at present prints a trifle too dark; this may easily be done by the use of mat varnish on the back of the negative in the way described in our recent No. 24.

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